

THE PERIOD ANALYSIS OF V418 AQL, SU BOO, RV CVN, CR CAS, GV CYG, V432 PER, AND BD+42 2782.

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ABSTRACT

The minimum timings of eclipsing binaries V418 Aql, SU Boo, RV CVn, CR Cas, GV Cyg, V432 Per, and BD+42 2782 were collected and analyzed. Their long-term behavior was studied via period analysis, revealing a periodic term in eclipse times. We derived 576 new times of minimum. Hence, to describe the periodic variation, a thirdbody hypothesis was proposed and the resulting orbital periods are as follows: 70, 7.4, 53, 37, 27, 53, and 18 yr, respectively. For the system V432 Per an additional 9.5 yr variation was also found. The predicted minimum masses of these distant bodies were calculated and their detectability discussed. The light curves of SU Boo and RV CVn were analyzed using the PHOEBE program, resulting in physical parameters of the components. New variable stars in the field of V418 Aql were discovered.

Subject headings: binaries: eclipsing — stars: fundamental parameters — stars: individual: V418 Aql, SU Boo, RV CVn, CR Cas, GV Cyg, V432 Per, and BD+42 2782.

1. INTRODUCTION

More than a century of intensive study of the eclipsing binaries (hereafter EBs), these objects still represent the best method how to derive the masses, radii and luminosities of the stars. Moreover, discovering the additional components in these systems is also rather straightforward using the precise times of minima and analysing the period variation of the eclipsing pair, a so-called light-time effect (hereafter LITE), Irwin (1959) or Mayer (1990).

The method of period analysis, despite its classical nature and many decades of usage (about 250 such systems known nowadays, see e.g. Zakirov 2010), still provides us with an efficient method of discovering the hidden components in the eclipsing systems. Its main advantage is the easiness of use because of huge datasets of times of eclipses. The other profit is that this method is able to reveal the hidden components otherwise hardly detectable: the short-periodic ones can be easily detected via spectroscopy, while the long-period ones as visual or interferometric doubles. Hence, the period gap in between can be harvested via period analysis in these systems - it is adequately sensitive to relatively low masses, independent of luminosities of the third bodies and also only mildly dependent on the orbit orientations (only the body orbiting perpendicular to the EB orbit cannot be detected). And finally, its usefulness also for the huge photometric databases was shown (e.g. by Rappaport et al. 2013).

2. METHODS

Only for a brief repetition of the method of period analysis using the LITE hypothesis:

$$\tau = \frac{A}{\sqrt{1 - e^2 \cos^2 \omega}} \left[\frac{(1 - e^2) \cdot \sin(\nu + \omega)}{1 + e \cos \nu} + e \sin \omega \right] \quad (1)$$

is the delay of the light-time orbit as the body moves around a common barycenter (see e.g. Mayer (1990) for explanation of the individual parameters). This delay is periodically changing with respect to the current orbital phase, hence the times of minima for a particular system are being observed earlier and later than predicted from the linear ephemerides. For some of the systems also the quadratic term in ephemerides was used. Hence another parameter of a rate of period change \dot{q} was introduced. This continuous period change is often attributed to the mass transfer between the close eclipsing components. The mass transfer is slowly moving the barycenter of the double and hence also the period of the pair itself. Using the hypothesis of a conservative mass transfer (i.e. no mass loss from the system), the well-known equation introduced e.g. by Hilditch (2001) can be used to compute the estimated rate of the mass transfer:

$$\frac{1}{P} \frac{dP}{dt} = 3 \frac{M_1 - M_2}{M_1 M_2} \frac{dM_1}{dt}, \quad (2)$$

where M_i are the masses of primary and secondary component, respectively.

There are still many eclipsing systems lacking of detailed period analysis despite the fact that their observations exist in various databases. For example the automatic photometric projects (like ASAS (Pojmanski 2002), Super WASP (Pollacco et al. 2006), "Pi of the sky" (Burd et al. 2005), NSVS (Woźniak 2004), OMC (Mas - Hesse et al. 2004) and others) monitor the sky continuously, and the data are publicly available. These data points can be used either for deriving the times of minima, or for the complete light curve (hereafter LC) analysis. For our study we have chosen several rather neglected eclipsing binaries on the northern sky for their availability from our observatories.

3. NEW PHOTOMETRIC OBSERVATIONS

New observations were mostly obtained at Ondřejov observatory in Czech Republic, using the 65-cm reflector equipped with the MI G2-3200 CCD camera. The standard R photometric filter was used, while the exposing times were chosen according to the brightness of the target (usually 10-90 s). The only exception was the star BD+42 2782, which is too bright for this telescope, hence it was observed by one of the authors (RU) with small 34-mm and 200-mm telescopes at the private observatory in Jílové u Prahy in Czech Republic. The observations were obtained using the standard R filter, or without any filter.

All of the observations were routinely reduced in a standard way, using the dark frames and flat fields. The resulting photometry was used for deriving the times of minima for a particular system. The standard Kwee-van Woerden procedure (Kwee & van Woerden 1956) was used for the derivation of the times of minima. And finally, the heliocentric correction was applied to the data points. All of the data points used for the analysis are stored in the Appendix Tables below. All of these times of minima are the heliocentric ones (HJD). Also the accuracy of the particular minima are given in the tables, for our new derived ones as well as for the already published ones (if available).

4. THE INDIVIDUAL SYSTEMS UNDER ANALYSIS

In the present analysis we included only such systems, which satisfy all of the following criteria:

- Northern-sky eclipsing binary in the range 9 – 15 mag and orbital period up to 3 days
- The times-of-minima data set is sufficiently large for a period analysis
- The variation in the $O - C$ diagram shows periodic variation and at least one period of such variation is covered nowadays
- The system was not studied before, or a new solution significantly differs from the published one
- At least a few new minima times observations were obtained by the authors during the last years

Using these criteria, seven systems were found to be suitable for the analysis.

4.1. *V418 Aql*

V418 Aql (= AN 115.1930, $V=11.6$ mag) was discovered as a variable star by Guthnick & Schneller (1939), who also correctly classified the star as an Algol-type. However, since then only a few studies on this star was published, and no detailed photometric or spectroscopic study was performed. The spectral type was classified as F8III (Halbedel 1984), but based on only fair quality of spectrograms. Later, Locher (1987) published his finding on the duration of the totality of the primary eclipse of about 2 hours, which is only a bit longer than derived from our new observations ($1^{\text{h}}43^{\text{m}}$). Moreover, the system V418 Aql comprises two components, see the Washington double star catalogue, WDS (Mason et al. 2001). The secondary component is about $17''$ distant.

We collected all available times of minima of V418 Aql, see the Appendix Table 4. For deriving new times of minima we also used the public available photometry obtained for the ASAS survey (Pojmanski 2002), NSVS

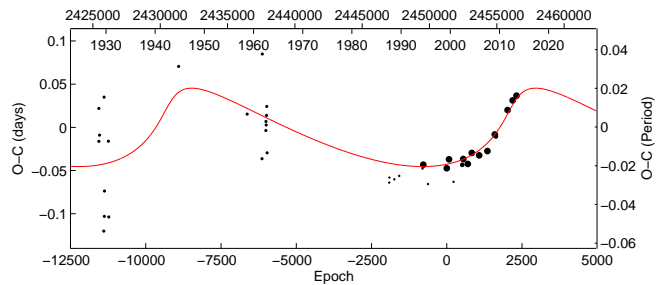


FIG. 1.— Period analysis of V418 Aql. The individual times of minima are plotted as dots, bigger the symbol, higher the weight, while the continuous curve represents the final fit, see the text for details.

survey, and the OMC camera onboard the INTEGRAL satellite. Two new minima were also observed during the last year by the authors. The data were analysed applying the LITE hypothesis. See Fig. 1 for the final result, the parameters of the LITE orbit are given in Table 1. In this table there are presented all the fitted parameters from the LITE hypothesis together with their respective errors. However, it is necessary to emphasize that these errors are only formal errors as resulted from the fitting procedure (for the estimation of errors from the covariance matrix see e.g. Press et al. 1986). Hence, these mathematical errors can sometimes be 2 to 5 times lower than more reliable physical uncertainties of the individual parameters. As one can see, the periodic variation is clearly visible, its period is about 70 years, while the periastron passage will occur in upcoming years. Hence, new observations would be very welcome.

One can argue, that the whole analysis and our solution is based on one crucial point only, the one near the last periastron in 1944. However, this is not true. We tried to perform a similar analysis using only the data after 1950, and using only the quadratic term in ephemerides with no LITE variation. But this approach did not led to the better result due to the fact that the curvature of the points is not symmetric for a parabola and some of the points significantly deviate.

From the LITE hypothesis there arises that the mass function of the third hidden body is about $0.2 M_{\odot}$, hence one can speculate about its nature. Using the easiest assumption about the coplanarity of the both orbits (and using the total mass of the eclipsing pair about $1.6 M_{\odot}$), there resulted the minimal mass of the third body about $1.1 M_{\odot}$. Such a component should be easily detectable in the light curve solution and should be also visible in the spectra of the system. New detailed analysis is hence needed. And finally, there also arises that this third component is different than the one observed visually, hence we deal with at least a quadruple stellar system.

One can also ask whether such a picture of the system is self-consistent with the individual luminosities. Using the spectral type F8III as derived by Halbedel (1984), its absolute bolometric magnitude is about 3 mag brighter than the normal main sequence F8 stars (see e.g. Cox 2000). About the same spectral type was also derived using the photometric indices $(V - K)$ and $(J - H)$ of V418 Aql observed by 2MASS survey (Skrutskie et al. 2006). According to our observations, the primary minimum is about 2.36 mag deep, while the secondary about 0.04 mag only. Hence, the primary giant component contributes about 90% of the total luminosity of the system

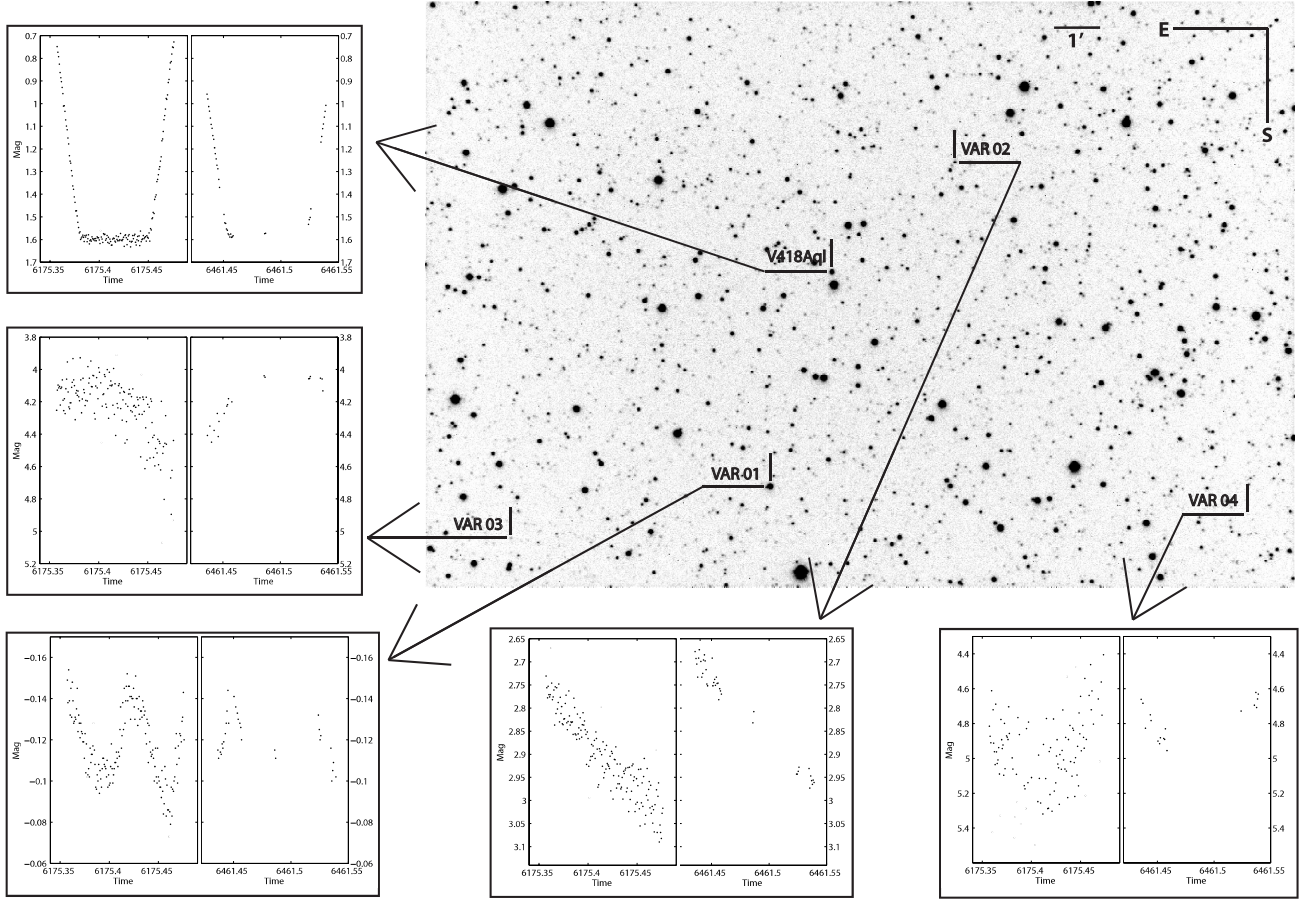


FIG. 2.— Identification chart for the field of V418 Aql and the surrounding new variables, see the text for details.

and is the absolutely dominant source. This is also the reason, why the observed combined spectral type F8III is mainly the spectral type of the primary component. We tried to find out the individual properties of the three components in the system from our (poorly covered) light curve. There resulted that the secondary is probably a subgiant of spectral type about M1IV. Hence, the total mass of the eclipsing binary is about $1.2 + 0.4 = 1.6 M_{\odot}$. From the fitting procedure there was also derived that the value of the third light is about 4% of the total light. The light contribution of the third body with mass $1.1 M_{\odot}$ (i.e. about G5V spectral type) as derived from the LITE analysis is about 3.5%, which is in excellent agreement.

Moreover, during the observations of V418 Aql we discovered several new variable stars in the field. See Fig. 2 for the identification chart and position of the new variables near V418 Aql. Our two nights of observations are plotted for each of these stars. The brightest one (designated as VAR 01) is the star GSC 0048604545 (= 2MASS 19364467 +0352167, RA $19^h 36^m 44^s.70$, DE $+03^{\circ} 52' 16''.3$). It is a rapidly pulsating star, probably of δ Scuti type. Its variations are of about 0.07 mag in R filter, while the period of pulsations is about 1.5 hours. The second star (VAR 02) is 2MASS 19362870 +0359267 (RA $19^h 36^m 28^s.73$, DE $+03^{\circ} 59' 27''.0$), but its type is unknown, having the amplitude at least 0.35 mag. The two other new variables (VAR 03 = 2MASS 19370740

+0351051, RA $19^h 37^m 07^s.40$, DE $+03^{\circ} 51' 05''.17$ and VAR 04 = 2MASS 19360258 +0351466, RA $19^h 36^m 02^s.58$, DE $+03^{\circ} 51' 46''.64$) are rather faint, but their variations are still visible in the data, see Fig. 2.

4.2. SU Boo

Another star in our sample is SU Boo (= AN 78.1914, $V=11.9$ mag). It was discovered as a variable by Beljawsky (1914), while later Broglia (1960) performed the first analysis of its light curve. It is the classical Algol-type binary with deep primary and shallow secondary minima, orbital period is of about 1.5 days, and the spectral type was derived to be A3V/A4V (Hill et al. 1975). The inclination of the system is about 81.5° according to Broglia (1960), however later Mardirossian et al. (1980) published the value $i = 86.3^{\circ}$. Therefore, such a large discrepancy is noteworthy and new LC analysis would be profitable.

We collected all available times of minima published since its discovery. These are given in Table 4, including our six new measurements. Most of the data points used for the analysis were derived using the WASP (Pollacco et al. 2006) photometry, the NSVS photometry (Woźniak 2004), and two also from the CRTS data (Drake et al. 2009). The resulting $O - C$ diagram is plotted in Fig. 4, where the periodic variation is clearly visible, nowadays covering several cycles. We used the same approach as for V418 Aql and the LITE hypothesis to analyse the period variations. The parameters

TABLE 1
FINAL PARAMETERS OF THE LITE ORBITS.

Parameter	V418 Aql	SU Boo	RV CVn	CR Cas	GV Cyg	BD +42 2782
JD_0	2451276.4853 (106)	2453142.5733 (18)	2444374.6415 (16)	2440529.0619 (96)	2450283.4500 (45)	2444423.3372 (19)
P [d]	2.23490129 (168)	1.56125039 (20)	0.26956736 (3)	2.84019694 (262)	0.99066628 (56)	0.37015161 (9)
p_3 [day]	25548.4 (953.1)	2709.1 (24.8)	19397.8 (852.3)	13553.0 (789.6)	9847.1 (442.9)	6470.60 (67.49)
p_3 [yr]	69.95 (2.61)	7.42 (0.07)	53.1 (2.3)	37.1 (2.2)	27.0 (1.2)	17.7 (0.2)
A [day]	0.0453 (96)	0.0076 (5)	0.0074 (9)	0.0451 (32)	0.0079 (8)	0.0099 (5)
T_0	2430626.6 (760.0)	—	2453523.1 (892.0)	—	—	2490833.6 (133.6)
ω [deg]	27.9 (15.8)	—	131.5 (31.9)	—	—	85.5 (6.8)
e	0.658 (0.305)	0.000 (0.001)	0.413 (0.014)	0.000 (0.001)	0.000 (0.001)	0.546 (0.090)
q [10^{-10} d]	—	1.695 (0.001)	0.024 (0.001)	24.04 (0.01)	0.693 (0.003)	—
$f(m_3)$ [M_\odot]	0.184 (56)	0.045 (0.002)	0.001 (0.001)	0.347 (0.015)	0.004 (0.001)	0.016 (0.001)
$M_{3,min}$ [M_\odot]	1.1 (0.3)	0.97 (0.05)	0.17 (0.07)	6.63 (0.89)	0.29 (0.08)	0.51 (0.05)
\dot{M} [M_\odot/yr]	—	$1.8 \cdot 10^{-7}$	$9.9 \cdot 10^{-8}$	$3.2 \cdot 10^{-6}$	$9.4 \cdot 10^{-9}$	—

TABLE 2
THE PARAMETERS OF THE LIGHT CURVES OF SU BOO AND RV CVn AS DERIVED FROM THE ANALYSIS.

Parameter	SU Boo		RV CVn	
	Value	Error	Value	Error
T_1 [K]	8450 (fixed)	—	6100 (fixed)	—
T_2 [K]	5090	60	5564	75
i [deg]	83.18	0.14	84.75	0.25
Ω_1	5.075	0.013	3.039	0.013
Ω_2	5.717	0.020	—	—
L_1 [%]	94.5	0.7	50.1	0.5
L_2 [%]	5.5	0.2	49.9	0.5
r_1/a	0.239	0.007	0.482	0.005
r_2/a	0.184	0.006	0.481	0.005
$q = M_2/M_1$	0.852	0.005	0.93	0.03
e	0.00 (fixed)	—	0.00 (fixed)	—
$F_1 = F_2$	1.00 (fixed)	—	1.00 (fixed)	—
$A_1 = A_2$	1.00 (fixed)	—	0.50 (fixed)	—
$g_1 = g_2$	1.00 (fixed)	—	0.32 (fixed)	—

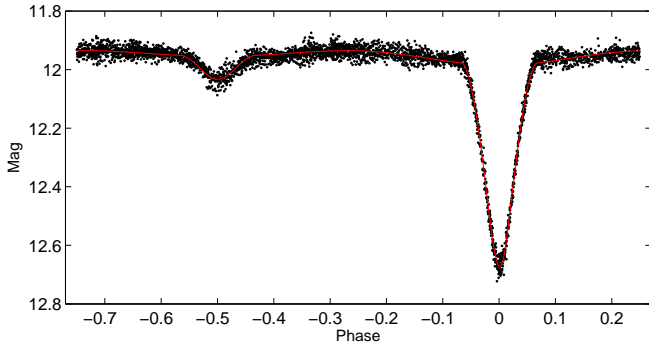


FIG. 3.— Light curve of SU Boo from the WASP survey and our final fit.

of the LITE fit are written in Table 1. The period of LITE variation is about only 7.4 years, which makes this system even more interesting. Moreover, there was detected also a slow steady increase of the period of the eclipsing pair (see the blue dash-dotted line in Fig. 4), probably caused by a mass transfer between the close components. If we use eq.2 we can estimate its rate to be about $2 \cdot 10^{-7} M_\odot/\text{yr}$, which is quite realistic value for a conservative mass transfer in eclipsing binary.

We used the WASP data for the LC analysis. Despite having no spectroscopy and the radial velocities, some of the parameters have to be fixed or only estimated. At first, the ephemerides were fixed according to the period analysis. Secondly, the albedo and gravity darkening values were kept fixed at their suggested values for stars with radiative envelopes (i.e. $A_i = 1$,

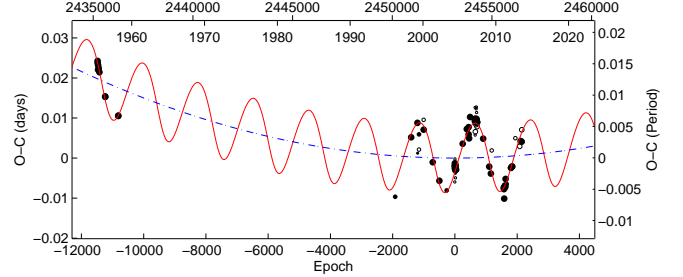


FIG. 4.— Period analysis of SUBOO. The open circles stand for the secondary, while the filled dots for the primary minima. The blue dash-dotted line represents the quadratic term in ephemerides.

$g_i = 1$, $i = 1, 2$). The temperature of the primary component was kept fixed at a value of $T_1 = 8450$ K, in agreement with its spectral type (Harmanec 1988). We used the program PHOEBE, ver. 0.31a (Prša & Zwitter 2005), which is based on the Wilson-Devinney algorithm (Wilson & Devinney 1971) and its later modifications. For the whole computation process the eccentricity was fixed at zero. The limb-darkening coefficients were automatically interpolated from the van Hamme's tables (van Hamme 1993).

During the fitting process, we finally get the answer why there was so large discrepancy between the two inclination angles published previously. Starting with equal components ($q = 1$), the inclination resulted in $i = 81.5^\circ$, while if we fit the mass ratio, it decreases and hence the inclination increases. We get the smallest possible value of the chi-square when the value of $q = 0.85$ and the inclination about $i = 83.2^\circ$. Moreover, the solution presented by Broglia (1960) is doubtful because of $q > 1$, which is rather improbable. For our final solution see Fig. 3 and the parameters of the light curve given in Table 2. As one can see, the primary component dominates the system luminosity and also the mass.

The resulting mass function of the predicted third body (see Table 1) yields the minimal mass of such component of about $1 M_\odot$ (with the assumption that the orbits are coplanar and the masses of the eclipsing components are 1.95 and $1.66 M_\odot$). It is noteworthy that no additional third light was detected in the LC solution. Assuming a normal main sequence star, then such a component should contribute about 3% to the total light, which probably should be detectable. More precise observations are needed. However, one can also speculate about an underluminous or even binary nature of the third star. From the estimated luminosities of all components, the photometric distance to the system was derived to be of about 1.5 kpc.

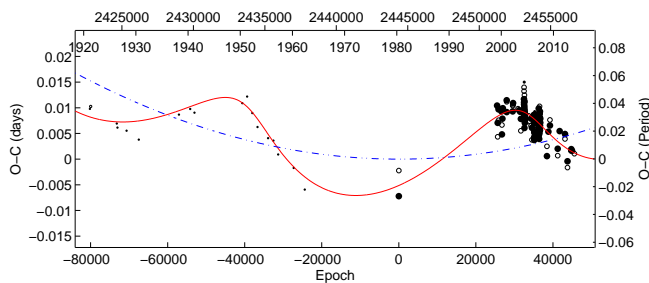


FIG. 5.— Period analysis of RV CVn.

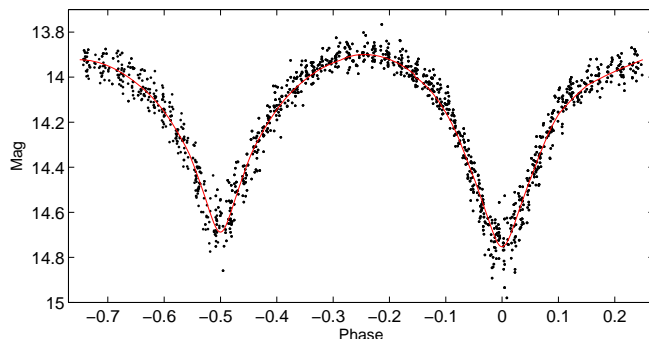


FIG. 6.— Light curve of RV CVn from the WASP data.

4.3. RV CVn

RV CVn (= AN 4.1921, $V=14.9$ mag) is another seldom investigated eclipsing binary system. It is the W UMa-type star, discovered as a variable by Larink (1921). Its spectral type was derived as F8, according to Schilt (1927). In this latter paper, Schilt stated that the star is of W UMa type, but no reliable LC solution was given. Moreover, there was a discussion about its membership to the cluster NGC 5272 (= M 3), which seems nowadays rather improbable. Another paper by Hoffmann (1981) also presented only the light curves, but no LC solution to the data. Since then, many new observations of times of minima were published, however no reliable LC solution is available till now.

Hence, we collected all the minima observations for a period analysis as well as the data obtained within the WASP survey project for the LC analysis. For the LC analysis a similar approach as for SU Boo was used: the primary temperature was fixed at a value of 6100 K (i.e. spectral type F8), and the circular orbit. The relevant light curve quantities are given in Table 2. As one can see, both the components are similar to each other, the LC fit is plotted in Fig.6. The contact configuration of the system is obvious, as it is usual for these type of compact W UMa-type systems.

The set of times of minima is rather huge nowadays: 153 new minima were derived from the WASP photometry, 6 new from the LINEAR data (Sesar et al. 2011), while 10 from the CRTS survey. Eight new observations were obtained by the authors. All of the used minima are given in Appendix Tables 4. The periodic variation is clearly visible, despite rather large scatter of the older visual or photographic observations (we believe all published data are trustworthy due to rather deep eclipses, so all of them were used for the analysis). Hence, we followed the same procedure as for the previous systems and the LITE hypothesis was used. The resulting fit is

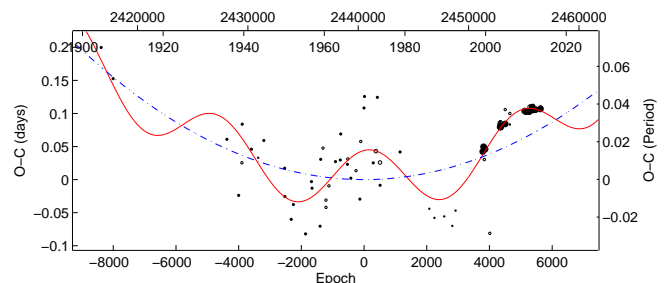


FIG. 7.— Period analysis of CR Cas.

plotted in Fig. 5, while its parameters are written in Table 1. Besides the 52-yr LITE variation there was also detected a steady period increase. However, it is rather slow, so the mass transfer between the components is only about $10^{-7} M_{\odot}/\text{yr}$. Such a value is reliable for the contact binary like RV CVn.

From the resulting mass ratio from the LC analysis ($q = 0.93$), and using the assumption of the main sequence primary component, we can estimate the mass of the secondary. With this mass using the LITE hypothesis one can also calculate the mass function of the third hidden component, which leads to the minimal mass (i.e. $i_3 = 90^\circ$) of the third body $M_{3,\min} = 0.17 M_{\odot}$. Therefore, if such body orbits on coplanar orbit with the eclipsing pair, then its light contribution to the total luminosity of the binary should be negligible. This is also the result of our LC analysis, where no additional third light was found. Also the interferometric detection is inapplicable because of its low luminosity.

4.4. CR Cas

The system CR Cas (= AN 450.1934, $V=11.70$ mag) was discovered as a variable star by Nielsen (1935). Later (Guthnick & Schneller 1939) was classified as an Algol-type with the orbital period about 1.42 days, half of the correct value. Its spectral type according to the SIMBAD database is K8, which is definitely wrong. The precise UB V photometry outside of eclipse published by Lacy (1992) was used to derive the unreddened index $(B - V)_0 = -0.27$ mag. Almost the same value of $(B - V)_0$ was derived using the values of Strömgren magnitudes by Clement & Fabregat (1998) (following the method described in Harmanec & Božić (2001)). This $(B - V)_0$ index corresponds to the spectral type B0.5V-B1V (Popper 1980). Later, Popper (1996) gives the type of B. The most detailed analysis of the star was published by Clement & Fabregat (1998). They obtained the $uvby$ photometry and the consequent analysis yielded that the components are probably of B0.5V and B1V spectral types, but located away from the Sun (more than 3.5 kpc, the reddening of the system is $E(b - y) = 0.621$). Moreover, our observations show that the system has total eclipses (lasting about 45 minutes).

We collected all available published times of minima for the period analysis. Moreover, 14 new minima were derived from the NSVS and OMC photometry, and a few other minima were observed by the authors. All of these data are stored in the Appendix Tables. The same period analysis was used as in the previous cases, yielding a set of LITE parameters given in Table 1. As one can see from Fig.7, the periodic variation is clearly visible nowadays, even despite rather large scatter of the older visual obser-

variations. Moreover, there was also detected rather rapid period increase (i.e. fitting also the quadratic term in ephemerides). Clement & Fabregat (1998) speculated about the emission-type secondary component, which probably should be connected with the rapid mass transfer between the components. From our analysis there resulted the value of about $3 \cdot 10^{-6} M_{\odot}/\text{yr}$, which is the largest mass transfer in our sample. Nevertheless, as noted e.g. by Hilditch (2001), such a value is still possible on a thermal-time scale in binaries. On the other hand, without the detailed spectroscopic analysis, this is still only a hypothesis.

From the third-body fit, we can also derive the mass function ($f(m_3) = 0.347 \pm 0.015 M_{\odot}$), from which the minimal mass of the third body resulted in about $6.6 M_{\odot}$. Hence, we can speculate about its detectability in the LC solution performed by Clement & Fabregat (1998). The third light fraction resulted in more than 6% of the total light, which should be detectable. However, the authors did not test the presence of additional light in their LC solution. We can also compute the predicted angular separation of the third component assuming the coplanar orbits and using the photometric distance as derived by Clement & Fabregat (1998). This resulted in about $\alpha = 9.4$ mas, which is within the capabilities of modern stellar interferometers, however its low luminosity makes it probably undetectable with nowadays facilities.

4.5. *GV Cyg*

The system *GV Cyg* (= AN 354.1929, $V=13.2$ mag) is the least studied system in our sample. It is the Algol-type eclipsing binary with the orbital period of about 0.99 day. It was discovered as a variable by Hoffmeister (1930). The first brief analysis and the LC of the system was published by Ahnert et al. (1941), which revealed rather deep primary eclipse of about 2 magnitudes, and probably rather shallow secondary. The updated ephemerides were presented by Wood & Forbes (1963), while its spectral type was estimated of about A5 by Brancewicz & Dworak (1980). However, no detailed LC and RV analysis exist and the published papers during the last two decades only contain new times of minima observations.

Hence, we collected all available minima timings, as well as a few our new observations for a period analysis. Our complete data set consists of more than 70 observations spanning over 80 years. All of the data points are stored in Appendix Tables. As one can see from Fig.8, the periodic variation is clearly visible especially on the more precise observations obtained during the last two decades.

The LITE hypothesis applied to the data points led to the parameters presented in Table 1. The period of LITE variation resulted in about 27 years, while the amplitude is about 11 minutes. Using the very rough parameters of the system as published by Budding et al. (2004), we can calculate the predicted minimal mass of the third component. This resulted in about $0.3 M_{\odot}$ (hence an M dwarf), which should contribute only negligible and hardly detectable portion to the total luminosity. Only detailed spectral analysis would detect such body in the system via spectral disentangling. The quadratic term in ephemerides show some indication of a slow mass transfer between the eclipsing components, the smallest in our

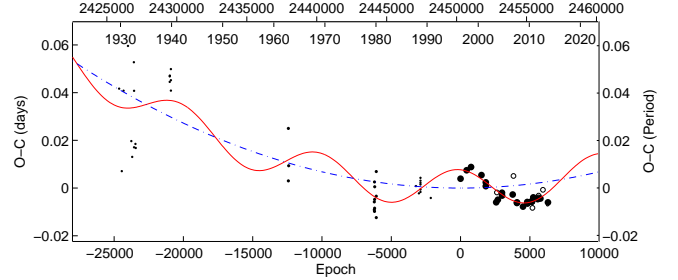


FIG. 8.— Period analysis of *GV Cyg*.

TABLE 3
FINAL PARAMETERS OF THE TWO LITE ORBITS OF *V432 Per*.

Parameter	Value
JD_0	2448601.3757 ± 0.0020
P [d]	$0.38330916 \pm 0.00000013$
p_3 [day]	19125.4 ± 927.5
p_3 [yr]	52.36 ± 2.54
A [day]	0.0324 ± 0.0022
T_0	2439151.2 ± 781.3
ω [deg]	180.9 ± 14.7
e	0.459 ± 0.141
p_4 [day]	3490.0 ± 150.9
p_4 [yr]	9.55 ± 0.41
A_4 [day]	0.0038 ± 0.0015
$T_{0,4}$	2451167.5 ± 182.7
ω_4 [deg]	127.3 ± 10.4
e_4	0.014 ± 0.008
$f(m_3) [M_{\odot}]$	0.092 ± 0.001
$M_{3,min} [M_{\odot}]$	0.81 ± 0.01
$f(m_4) [M_{\odot}]$	0.003 ± 0.001
$M_{4,min} [M_{\odot}]$	0.28 ± 0.01

sample, about only $9 \cdot 10^{-9} M_{\odot}/\text{yr}$.

4.6. *V432 Per*

The system *V432 Per* (= GSC 02856-01647 = TYC 2856-1647-1, $V=11.2$ mag) is probably the most often studied system in our sample. Its is relatively bright, with short orbital period (about 0.4 day), has deep minima (about 0.7 mag), and has high declination, which all make it an ideal target for observers from the northern hemisphere. Its first photoelectric lightcurves in *BV* filters were published by Agerer (1992), later Yang & Liu (2002) published the first LC solution of the system, revealing its asymmetric shape (O'Connell effect) and contact W UMa-type configuration. More recently, Lee et al. (2008) published their photometric study of the star, where they presented the spectral types for primary and secondary component as G4 and G8-9. Moreover, they also found a periodic modulation of minima timings, which led to period about 35 yr, which could be caused by a hidden M-type component. And finally most recent paper on the star by Odell et al. (2009), which benefits from a few spectral observations more or less affirms the results published by Lee et al. (2008).

Since its discovery, there were published about 200 times of minima. In spite of the fact that the set of minima is quite large and several studies on period changes were published, we still believe that its true nature is different than the already published one. The problem with the interpretation of the *O - C* diagram is that if we collect all available times of minima and use the

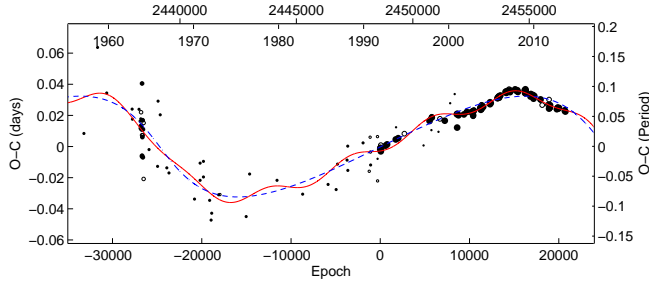


FIG. 9.— Period analysis of V432 Per. The blue dashed line stands for the third body, while the red solid one for the final fit of both LITE terms.

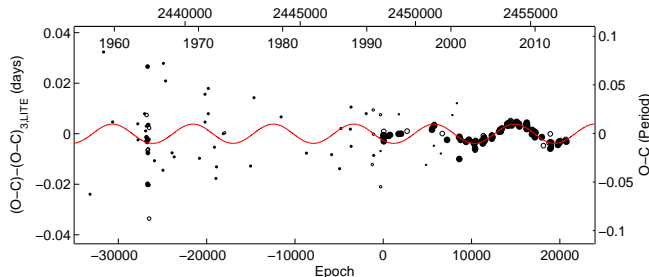


FIG. 10.— Period analysis of V432 Per, after subtraction of the third-body LITE term.

LITE hypothesis as presented in published papers, there still remains an unexplainable variation of the residuals. Hence, we believe that one has to use two LITE terms for describing the data in detail.

Therefore, we applied double LITE hypothesis, hence twelve parameters were fitted in total. The list of all available data found in literature is given in Appendix Tables, while our results are written in Table 3. The final fit is presented in two Figs. 9 and 10, where both LITE terms are plotted to the available data points. Despite rather large scatter of the older visual and photographic minima, the most recent data obtained during the last decade clearly shows the additional variation superimposed on the third-body LITE orbit. However, such approach is nothing novel, the double periodic LITE hypothesis was used for several eclipsing systems, see e.g. Borkovits & Hegedüs (1996).

We can only speculate about the nature of these variations. Lee et al. (2008) presented that the period modulation is most probably caused by the third body orbiting around the EB pair, and also the third light contribution found in the LC solution originates from this component. However, in our case the problem is more complicated due to two other components. Their total luminosity has to be lower than detected l_3 in the LC solution presented by Lee et al. (2008), however to disentangle their individual contributions is impossible. Moreover, using the distance to the system as presented in Lee et al. (2008), we can compute the predicted angular separation of the third and fourth body in the system for a prospective interferometric detection. For the third body there resulted the separation about 68 mas, while for the fourth body about 23 mas. The hope of finding these bodies is diminished due to rather low brightness of the system. Hence, spectroscopic detection via disentangling seems to be nowadays the best method how to solve this problem.

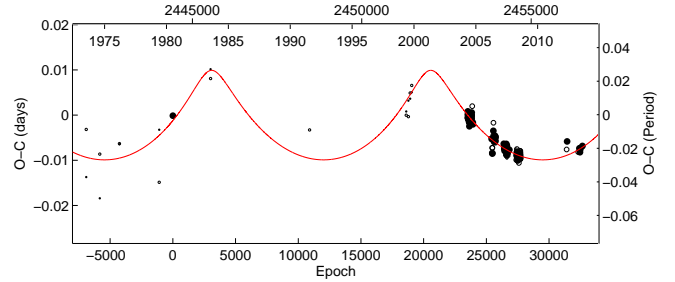


FIG. 11.— Period analysis of BD +42 2782.

4.7. BD +42 2782

BD +42 2782 (= TYC 3080-1410-1, $V=9.5$ mag) is the brightest star in our sample, and also the system studied in the most detailed analysis. It was discovered as a variable by Sokolovsky & Antipin (2005). A detailed LC and RV analysis of the star was performed by Lu et al. (2007). They derived that the system is in contact, its curve is of W UMa-type, having a cool spot on the primary component, which is surprisingly underluminous. Its spectrum is probably about F5 and distance was derived to be of about 124 pc. Moreover, there is also a visual component about $3.5''$ distant, which contributes about 6.5% to the total light of the system.

Despite having a huge set of photometric observations from the WASP survey covering whole LC, we decided not to perform the LC analysis due to more detailed LC+RV analysis published by Lu et al. (2007) based on precise observations obtained in two filters. However, the WASP data were used for the minima times derivation and hence the collection of minima (see Table 4) is rather large. Moreover, we derived also new minima from the discovery paper by Sokolovsky & Antipin (2005), from TYCHO (Perryman et al. 1997), from NSVS, and our new recent observations. However, there arises two major problems, at first the amplitude of photometric variations is about 0.25 mag, while the precision of individual photometric observations published by Sokolovsky & Antipin (2005) is 0.01 mag. A similar problem is with the data sampling (it is the sparse photometry, two subsequent data points are more than 24 minutes separate, which is about 1/20 of the orbital period). All of these make the scatter of the older observations rather large.

As one can see from Fig. 11, the periodic variation is pretty well covered nowadays. Applying the LITE hypothesis to the data, we get the parameters given in Table 1. There are only two cycles covered with observations, however the variation is evident, mainly during the last two decades. One can ask how reliable the fit presented in Fig.11 is, but the lack of other observations prevent us to do more for the analysis. The period of LITE was derived relatively well, but the amplitude should be a bit different because of poor coverage near both periastron passages.

From the LITE hypothesis there arises that the predicted minimal mass of the third body should be about $0.5 M_{\odot}$, which should be detectable in the LC solution. However, dealing with the visual component and also this predicted third one, we cannot disentangle the third light into the contributions from the individual components. Hence we also deal with quadruple system. Using the

distance to the system as derived by Lu et al. (2007), we can also estimate the predicted angular separation of the third component from the eclipsing pair. This value resulted in about $a = 78 \pm 10$ mas, which should be easily detectable with nowadays stellar interferometers. However, there arises a problem with its luminosity. It should be more than 3 mag fainter than the eclipsing pair (which itself is rather faint for interferometry), so its detection is right on the limit of nowadays technique.

5. CONCLUSION

We performed the period analysis of times-of-minima for seven rather seldom-investigated eclipsing systems, where the third component orbiting around the EB pair was suggested as a realistic hypothesis. For some of these systems the periods are adequately short for the third body to be discovered via spectroscopic monitoring during several seasons. For some others the third light contribution to the total light in the LC solution was discussed as a most promising technique of detection. We also discussed the possibility of interferometric detection of the additional components, but this was mostly ruled out due to their low luminosities. Moreover, for the prediction of angular separation of the third components the distance of the systems from the Sun is needed, which is still the unavailable information for some of the systems.

The most interesting system in our sample is probably CR Cas, being the most distant and also the most massive system in our sample. Moreover, besides a proposed third body orbiting around the EB pair with period about 37 yr, there was derived a rather rapid mass transfer between the eclipsing components. Hence, the system is maybe in some interesting evolutionary stage. Another noteworthy system is also SU Boo, having the shortest period of the third body in our sample about 7.4 yr only and also the significant mass transfer.

One can also ask whether such periodic variation is

presented in a specific kind of EBs, or it is quite common phenomenon. There arises (e.g. Chini et al. 2012) that most of the early-type stars are multiples, hence also the LITE should be detected for many of them. Usually, there is a problem with an insufficient data set for such an analysis. On the other hand, there are many EBs observed for decades, where no period variation was detected. Such systems are e.g. AA And, AE Cyg, ER Vul, and many others. For a catalogue of available $O - C$ diagrams of EBs see Paschke & Brát (2006), or Kreiner et al. (2001).

The benefit of such period analyses for the stellar multiplicity studies in general is undisputed. There exist a few hundreds of LITE systems, and their period variation is still being monitored. Hence, on the longer time scales one can still hope to find some dynamical effects due to the third bodies. All of our systems are certainly stable (from the ratio of periods), but generally the orbits of both inner and outer bodies are not stable and are subject of long-term precession, which can be studied in the future.

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TABLE 4
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
V418 Aql	25445.4800			Prim	Samus et al. (2012)
V418 Aql	25445.5180			Prim	Morgenroth (1938)
V418 Aql	25492.4200			Prim	Gessner (1966)
V418 Aql	25807.4300			Prim	Gessner (1966)
V418 Aql	25834.4040			Prim	Morgenroth (1938)
V418 Aql	25854.3800			Prim	Gessner (1966)
V418 Aql	25863.3490			Prim	Morgenroth (1938)
V418 Aql	26149.4740			Prim	Morgenroth (1938)
V418 Aql	26178.4400			Prim	Gessner (1966)
V418 Aql	31370.2900			Prim	Gessner (1966)
V418 Aql	36461.3400			Prim	Gessner (1966)
V418 Aql	37556.3900			Prim	Gessner (1966)
V418 Aql	37583.3300			Prim	Gessner (1966)
V418 Aql	37842.4900			Prim	Gessner (1966)
V418 Aql	37851.4400			Prim	Gessner (1966)
V418 Aql	37871.5500			Prim	Gessner (1966)
V418 Aql	37898.3800			Prim	Gessner (1966)
V418 Aql	37907.3300			Prim	Gessner (1966)
V418 Aql	37936.3300			Prim	Gessner (1966)
V418 Aql	47005.5250		C	Prim	Locher (1987)
V418 Aql	47023.4100		C	Prim	Locher (1987)
V418 Aql	47385.4620		C	Prim	Locher (1988)
V418 Aql	47747.5200		C	Prim	Locher (1989)
V418 Aql	49479.5770	0.004	C	Prim	Locher (1994)
V418 Aql	49535.4540	0.005	C	Prim	Paschke (1995)
V418 Aql	49888.5460	0.003	C	Prim	Locher (1995)
V418 Aql	51276.4380		V	Prim	Paschke & Brát (2006)
V418 Aql	51446.30083	0.00539	C	Prim	NSVS - This paper
V418 Aql	51781.5100	0.006	C	Prim	Locher (2000)
V418 Aql	52429.6510		V	Prim	Paschke & Brát (2006)
V418 Aql	52503.4095	0.0003	C	Prim	Agerer & Hübscher (2003)
V418 Aql	52838.63898	0.00286	V	Prim	ASAS - This paper
V418 Aql	53138.12852	0.00159	V	Prim	ASAS - This paper
V418 Aql	53685.67644	0.00344	V	Prim	ASAS - This paper
V418 Aql	54298.04441	0.00974	V	Prim	ASAS - This paper
V418 Aql	54845.61447	0.01468	V	Prim	ASAS - This paper
V418 Aql	54930.53848	0.00626	V	Prim	OMC - This paper
V418 Aql	55795.4758	0.0035	I	Prim	Hübscher & Lehmann (2012)
V418 Aql	56175.42018	0.00006	R	Prim	This paper
V418 Aql	56461.49308	0.00022	R	Prim	This paper
SU Boo	35219.4284		BG	Prim	Broglia (1960)
SU Boo	35222.5503		BG	Prim	Broglia (1960)
SU Boo	35244.4062		BG	Prim	Broglia (1960)
SU Boo	35247.5298		BG	Prim	Broglia (1960)
SU Boo	35272.5091		BG	Prim	Broglia (1960)
SU Boo	35311.5394		BG	Prim	Broglia (1960)
SU Boo	35600.3649		BG	Prim	Broglia (1960)
SU Boo	35603.4873		BG	Prim	Broglia (1960)
SU Boo	36254.5244		BG	Prim	Broglia (1960)
SU Boo	36257.6470		BG	Prim	Broglia (1960)
SU Boo	50149.6430	0.005	C	Prim	Paschke (1996)
SU Boo	50947.4574	0.0012	C	Prim	Diethelm (1998b)
SU Boo	51264.39507	0.00011	R	Prim	This paper
SU Boo	51273.7550		V	Prim	Paschke & Brát (2006)
SU Boo	51340.10909	0.00937	C	Sec	NSVS - This paper
SU Boo	51339.33226	0.00798	C	Prim	NSVS - This paper
SU Boo	51575.08242	0.00347	C	Prim	NSVS - This paper
SU Boo	51574.30426	0.00905	C	Sec	NSVS - This paper
SU Boo	52032.5210	0.003	C	Prim	Diethelm (2001)
SU Boo	52363.5017	0.0001	V	Prim	Šarounová & Wolf (2005)
SU Boo	52730.3934	0.0053	R	Prim	Zejda (2004)
SU Boo	53128.5187	0.00048	W	Prim	WASP - This paper
SU Boo	53138.6628	0.00115	W	Sec	WASP - This paper
SU Boo	53139.4481	0.00050	W	Prim	WASP - This paper
SU Boo	53142.5694	0.00038	W	Prim	WASP - This paper
SU Boo	53146.4748	0.00256	W	Sec	WASP - This paper
SU Boo	53153.4979	0.00022	W	Prim	WASP - This paper
SU Boo	53164.4256	0.00195	W	Prim	WASP - This paper
SU Boo	53164.4264	0.0040	I	Prim	Hübscher et al. (2005)
SU Boo	53167.5496	0.00029	W	Prim	WASP - This paper
SU Boo	53171.4501	0.00120	W	Sec	WASP - This paper
SU Boo	53178.4788	0.00032	W	Prim	WASP - This paper
SU Boo	53189.4072	0.00118	W	Prim	WASP - This paper
SU Boo	53192.5302	0.00210	W	Prim	WASP - This paper
SU Boo	53203.4578	0.00042	W	Prim	WASP - This paper
SU Boo	53228.4385	0.00100	W	Prim	WASP - This paper
SU Boo	53239.3681	0.00057	W	Prim	WASP - This paper
SU Boo	53534.4496	0.0016	C	Prim	Hübscher et al. (2006)
SU Boo	53738.9772	0.0001	R	Prim	Nelson (2007)
SU Boo	53829.52849	0.00511	V	Prim	CRTS - This paper
SU Boo	53832.6528	0.00119	W	Prim	WASP - This paper
SU Boo	53854.5075	0.00037	W	Prim	WASP - This paper
SU Boo	53904.4729	0.00078	W	Prim	WASP - This paper
SU Boo	54146.4658	0.00044	W	Prim	WASP - This paper
SU Boo	54149.5887	0.0005	I	Prim	Hübscher et al. (2009)
SU Boo	54152.7114	0.00029	W	Prim	WASP - This paper
SU Boo	54156.6105	0.00268	W	Sec	WASP - This paper

Note: W - special filter of the WASP survey

TABLE 5
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
SU Boo	54159.7399	0.00156	W	Sec	WASP - This paper
SU Boo	54163.6402	0.00052	W	Prim	WASP - This paper
SU Boo	54170.6626	0.00095	W	Prim	WASP - This paper
SU Boo	54185.4972	0.0006	I	Prim	Hübscher (2007)
SU Boo	54191.7428	0.00119	W	Prim	WASP - This paper
SU Boo	54195.6444	0.00160	W	Sec	WASP - This paper
SU Boo	54202.6711	0.00042	W	Prim	WASP - This paper
SU Boo	54206.5771	0.00036	W	Sec	WASP - This paper
SU Boo	54210.4774	0.00022	W	Prim	WASP - This paper
SU Boo	54213.5997	0.00022	W	Prim	WASP - This paper
SU Boo	54217.5063	0.00137	W	Sec	WASP - This paper
SU Boo	54221.4066	0.010	W	Prim	WASP - This paper
SU Boo	54224.5287	0.00063	W	Prim	WASP - This paper
SU Boo	54227.6515	0.00038	W	Prim	WASP - This paper
SU Boo	54231.5562	0.00118	W	Sec	WASP - This paper
SU Boo	54235.4569	0.00018	W	Prim	WASP - This paper
SU Boo	54249.5083	0.00044	W	Prim	WASP - This paper
SU Boo	54256.5327	0.00069	W	Prim	WASP - This paper
SU Boo	54260.4369	0.00027	W	Prim	WASP - This paper
SU Boo	54274.4875	0.0217	W	Prim	WASP - This paper
SU Boo	54558.63188	0.00211	V	Prim	CRTS - This paper
SU Boo	54861.5077	0.0003	C	Prim	Hübscher et al. (2010)
SU Boo	54947.3748	0.0005	UI	Prim	Hübscher & Monninger (2011)
SU Boo	54990.3150	0.020	C	Sec	Paschke (2009)
SU Boo	55601.53570	0.0005	R	Prim	Hoňková & Jurišek (2013)
SU Boo	55615.5842	0.0019	C	Prim	Hübscher et al. (2012)
SU Boo	55649.9350	0.0005	V	Prim	Diethelm (2011)
SU Boo	55660.8633	0.0003	V	Prim	Diethelm (2011)
SU Boo	55662.42481	0.0005	C	Prim	Hoňková & Jurišek (2013)
SU Boo	55687.4067	0.0022	I	Prim	Hübscher et al. (2012)
SU Boo	55960.62850	0.0001	R	Prim	Hoňková & Jurišek (2013)
SU Boo	55740.48800	0.003	C	Prim	Paschke (2012)
SU Boo	56010.58887	0.0001	R	Prim	Hoňková & Jurišek (2013)
SU Boo	55601.5353	0.0002	C	Prim	Hübscher & Lehmann (2012)
SU Boo	56175.30798	0.00108	R	Sec	This paper
SU Boo	56395.44241	0.00050	C	Sec	This paper
SU Boo	56438.37817	0.00028	R	Prim	This paper
SU Boo	56491.46055	0.00038	R	Prim	This paper
SU Boo	56495.36663	0.00135	R	Prim	This paper
RV CVn	22756.427			Prim	Larink (1921)
RV CVn	22811.5540			Sec	Graff (1923)
RV CVn	24642.5863	0.0020		Prim	Schilt (1927)
RV CVn	24642.587			Prim	Szeidl (1973)
RV CVn	24683.830			Prim	Szeidl (1973)
RV CVn	25326.478			Prim	Szeidl (1973)
RV CVn	26177.770			Prim	Szeidl (1973)
RV CVn	28991.519			Prim	Szeidl (1973)
RV CVn	29775.422			Prim	Szeidl (1973)
RV CVn	30078.415			Prim	Szeidl (1973)
RV CVn	33422.400			Prim	Szeidl (1973)
RV CVn	33763.404			Prim	Szeidl (1973)
RV CVn	34118.421			Prim	Szeidl (1973)
RV CVn	34487.456			Prim	Szeidl (1973)
RV CVn	35224.451			Prim	Szeidl (1973)
RV CVn	35600.497			Prim	Szeidl (1973)
RV CVn	35933.410			Prim	Szeidl (1973)
RV CVn	37018.416			Prim	Szeidl (1973)
RV CVn	37791.531			Prim	Szeidl (1973)
RV CVn	44374.5045		BV	Sec	Hoffmann (1981)
RV CVn	44375.4430		BV	Sec	Hoffmann (1981)
RV CVn	51247.8110	0.0005		Prim	Diethelm (2001)
RV CVn	51289.45307	0.00148	C	Sec	NSVS - This paper
RV CVn	51289.59059	0.00191	C	Prim	NSVS - This paper
RV CVn	51334.7461	0.0004		Sec	Diethelm (2001)
RV CVn	51354.96118	0.00144	C	Sec	NSVS - This paper
RV CVn	51355.09808	0.00186	C	Prim	NSVS - This paper
RV CVn	51555.6558			Prim	Šafář (2002)
RV CVn	51592.04292	0.00155	C	Prim	NSVS - This paper
RV CVn	51592.17953	0.00105	C	Sec	NSVS - This paper
RV CVn	51596.6303			Prim	Šafář (2002)
RV CVn	51626.5506			Prim	Šafář (2002)
RV CVn	51652.43110	0.0008		Prim	Brát et al. (2007)
RV CVn	51923.48233	0.0004		Sec	Brát et al. (2007)
RV CVn	51923.61511	0.0008		Prim	Brát et al. (2007)
RV CVn	51924.69569	0.0020		Prim	Brát et al. (2007)
RV CVn	52344.4099	0.0028	I	Prim	Agerer & Hübscher (2002)
RV CVn	52344.5458	0.0020	I	Sec	Agerer & Hübscher (2002)
RV CVn	52373.3897	0.0005		Sec	Agerer & Hübscher (2003)
RV CVn	52373.5248	0.0014		Prim	Agerer & Hübscher (2003)
RV CVn	52715.4699	0.0015		Sec	Agerer & Hübscher (2003)
RV CVn	52789.46584	0.0001	R	Prim	Kotková & Wolf (2006)
RV CVn	52863.3270	0.0001	R	Prim	Kotková & Wolf (2006)
RV CVn	52915.48458	0.00239	L	Sec	LINEAR - This paper
RV CVn	52915.62169	0.00102	L	Prim	LINEAR - This paper
RV CVn	53128.46171	0.00159	W	Sec	WASP - This paper
RV CVn	53129.52180	0.00249	W	Sec	WASP - This paper
RV CVn	53130.47072	0.00112	W	Prim	WASP - This paper

Note: W - special filter of the WASP survey, L - special filter of the LINEAR survey

TABLE 6
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
RV CVn	53130.61524	0.00285	W	Sec	WASP - This paper
RV CVn	53132.49109	0.00109	W	Sec	WASP - This paper
RV CVn	53132.62514	0.00183	W	Prim	WASP - This paper
RV CVn	53135.46001	0.00148	W	Sec	WASP - This paper
RV CVn	53137.47844	0.00068	W	Prim	WASP - This paper
RV CVn	53137.61079	0.00047	W	Sec	WASP - This paper
RV CVn	53138.41967	0.00076	W	Sec	WASP - This paper
RV CVn	53138.55520	0.00065	W	Prim	WASP - This paper
RV CVn	53139.50279	0.00209	W	Sec	WASP - This paper
RV CVn	53139.63538	0.00097	W	Prim	WASP - This paper
RV CVn	53148.2594	0.0002	C	Prim	Krajci (2005)
RV CVn	53150.42202	0.00105	W	Prim	WASP - This paper
RV CVn	53151.49321	0.00279	W	Prim	WASP - This paper
RV CVn	53152.44053	0.00069	W	Sec	WASP - This paper
RV CVn	53152.57298	0.00052	W	Prim	WASP - This paper
RV CVn	53153.51785	0.00058	W	Sec	WASP - This paper
RV CVn	53154.45846	0.00089	W	Prim	WASP - This paper
RV CVn	53155.53655	0.00095	W	Prim	WASP - This paper
RV CVn	53156.48316	0.00110	W	Sec	WASP - This paper
RV CVn	53157.42398	0.00139	W	Prim	WASP - This paper
RV CVn	53158.50433	0.00125	W	Prim	WASP - This paper
RV CVn	53159.44676	0.00156	W	Sec	WASP - This paper
RV CVn	53160.52571	0.00060	W	Sec	WASP - This paper
RV CVn	53161.46535	0.00441	W	Prim	WASP - This paper
RV CVn	53162.41524	0.00063	W	Sec	WASP - This paper
RV CVn	53162.54508	0.00108	W	Prim	WASP - This paper
RV CVn	53163.48956	0.00085	W	Sec	WASP - This paper
RV CVn	53165.51244	0.00065	W	Prim	WASP - This paper
RV CVn	53166.45578	0.00067	W	Sec	WASP - This paper
RV CVn	53167.53375	0.00098	W	Sec	WASP - This paper
RV CVn	53168.47627	0.00075	W	Prim	WASP - This paper
RV CVn	53170.49849	0.00055	W	Sec	WASP - This paper
RV CVn	53171.44220	0.00139	W	Prim	WASP - This paper
RV CVn	53173.46426	0.00059	W	Sec	WASP - This paper
RV CVn	53175.48459	0.00079	W	Prim	WASP - This paper
RV CVn	53178.45095	0.00059	W	Prim	WASP - This paper
RV CVn	53180.47375	0.00108	W	Sec	WASP - This paper
RV CVn	53182.49462	0.00115	W	Prim	WASP - This paper
RV CVn	53183.44030	0.00186	W	Sec	WASP - This paper
RV CVn	53192.46659	0.00193	W	Prim	WASP - This paper
RV CVn	53193.41422	0.00107	W	Sec	WASP - This paper
RV CVn	53195.43316	0.00058	W	Prim	WASP - This paper
RV CVn	53200.41997	0.00106	W	Sec	WASP - This paper
RV CVn	53202.44113	0.00205	W	Prim	WASP - This paper
RV CVn	53461.63098	0.00030	R	Sec	This paper
RV CVn	53534.4131	0.0017	C	Sec	Hübscher et al. (2006)
RV CVn	53623.09993	0.00199	L	Sec	LINEAR - This paper
RV CVn	53623.23608	0.00117	L	Prim	LINEAR - This paper
RV CVn	53686.98463	0.00138	V	Sec	CRTS - This paper
RV CVn	53687.12175	0.00252	V	Prim	CRTS - This paper
RV CVn	53769.61120	0.00200	R	Prim	This paper
RV CVn	53829.58944	0.00092	W	Sec	WASP - This paper
RV CVn	53830.53305	0.00129	W	Prim	WASP - This paper
RV CVn	53830.66681	0.00102	W	Sec	WASP - This paper
RV CVn	53831.61074	0.00125	W	Prim	WASP - This paper
RV CVn	53832.55555	0.00092	W	Sec	WASP - This paper
RV CVn	53832.69066	0.00103	W	Prim	WASP - This paper
RV CVn	53833.49906	0.00083	W	Prim	WASP - This paper
RV CVn	53833.63098	0.00245	W	Sec	WASP - This paper
RV CVn	53851.55597	0.00196	W	Prim	WASP - This paper
RV CVn	53852.50071	0.00053	W	Sec	WASP - This paper
RV CVn	53853.44244	0.00049	W	Prim	WASP - This paper
RV CVn	53853.57931	0.00146	W	Sec	WASP - This paper
RV CVn	53854.52124	0.00255	W	Prim	WASP - This paper
RV CVn	53855.46581	0.00090	W	Sec	WASP - This paper
RV CVn	53855.60067	0.00195	W	Prim	WASP - This paper
RV CVn	53856.40909	0.00070	W	Prim	WASP - This paper
RV CVn	53856.54269	0.00095	W	Sec	WASP - This paper
RV CVn	53884.44821	0.00359	W	Prim	WASP - This paper
RV CVn	54135.68053	0.00169	W	Prim	WASP - This paper
RV CVn	54140.67077	0.00077	W	Sec	WASP - This paper
RV CVn	54141.74866	0.00075	W	Sec	WASP - This paper
RV CVn	54142.69303	0.00073	W	Prim	WASP - This paper
RV CVn	54143.63627	0.00079	W	Sec	WASP - This paper
RV CVn	54145.65802	0.00335	W	Prim	WASP - This paper
RV CVn	54146.60157	0.00049	W	Sec	WASP - This paper
RV CVn	54146.73646	0.00069	W	Prim	WASP - This paper
RV CVn	54147.67952	0.00040	W	Sec	WASP - This paper
RV CVn	54149.70122	0.00042	W	Prim	WASP - This paper
RV CVn	54150.64372	0.00089	W	Sec	WASP - This paper
RV CVn	54152.66573	0.00059	W	Prim	WASP - This paper
RV CVn	54153.60916	0.00169	W	Sec	WASP - This paper
RV CVn	54153.74482	0.00255	W	Prim	WASP - This paper
RV CVn	54154.68785	0.00073	W	Sec	WASP - This paper
RV CVn	54155.63130	0.00059	W	Prim	WASP - This paper
RV CVn	54156.70960	0.00052	W	Prim	WASP - This paper
RV CVn	54157.65369	0.00066	W	Sec	WASP - This paper

Note: W - special filter of the WASP survey, L - special filter of the LINEAR survey

TABLE 7
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
RV CVn	54158.59653	0.00059	W	Prim	WASP - This paper
RV CVn	54158.73197	0.00089	W	Sec	WASP - This paper
RV CVn	54159.67443	0.00066	W	Prim	WASP - This paper
RV CVn	54161.69691	0.00169	W	Sec	WASP - This paper
RV CVn	54162.64233	0.00076	W	Prim	WASP - This paper
RV CVn	54166.68246	0.00163	W	Prim	WASP - This paper
RV CVn	54167.62684	0.00077	W	Sec	WASP - This paper
RV CVn	54169.64901	0.00039	W	Prim	WASP - This paper
RV CVn	54170.59113	0.00062	W	Sec	WASP - This paper
RV CVn	54170.72792	0.00156	W	Prim	WASP - This paper
RV CVn	54171.67080	0.00054	W	Sec	WASP - This paper
RV CVn	54172.61458	0.0002	R	Prim	Brát et al. (2007)
RV CVn	54189.59516	0.00083	W	Prim	WASP - This paper
RV CVn	54190.54036	0.00057	W	Sec	WASP - This paper
RV CVn	54190.67631	0.00151	W	Prim	WASP - This paper
RV CVn	54195.52856	0.00145	W	Prim	WASP - This paper
RV CVn	54197.94974	0.00076	V	Prim	CRTS - This paper
RV CVn	54198.08516	0.00106	V	Sec	CRTS - This paper
RV CVn	54202.53608	0.00038	W	Prim	WASP - This paper
RV CVn	54202.67021	0.00066	W	Sec	WASP - This paper
RV CVn	54203.47850	0.00123	W	Sec	WASP - This paper
RV CVn	54204.55792	0.00064	W	Sec	WASP - This paper
RV CVn	54206.44387	0.00060	W	Sec	WASP - This paper
RV CVn	54206.57969	0.00049	W	Prim	WASP - This paper
RV CVn	54208.46537	0.00182	W	Prim	WASP - This paper
RV CVn	54208.59889	0.00064	W	Sec	WASP - This paper
RV CVn	54210.48708	0.00066	W	Sec	WASP - This paper
RV CVn	54210.62245	0.00090	W	Prim	WASP - This paper
RV CVn	54211.43222	0.00056	W	Prim	WASP - This paper
RV CVn	54212.51132	0.00067	W	Prim	WASP - This paper
RV CVn	54212.64456	0.00058	W	Sec	WASP - This paper
RV CVn	54213.45190	0.00049	W	Sec	WASP - This paper
RV CVn	54213.58787	0.00065	W	Prim	WASP - This paper
RV CVn	54214.53186	0.00115	W	Sec	WASP - This paper
RV CVn	54215.47468	0.00067	W	Prim	WASP - This paper
RV CVn	54215.60936	0.00116	W	Sec	WASP - This paper
RV CVn	54216.55267	0.00053	W	Prim	WASP - This paper
RV CVn	54217.36248	0.00007	R	Prim	This paper
RV CVn	54217.49587	0.00099	W	Sec	WASP - This paper
RV CVn	54218.44171	0.00053	W	Prim	WASP - This paper
RV CVn	54218.57596	0.00162	W	Sec	WASP - This paper
RV CVn	54219.51922	0.00125	W	Prim	WASP - This paper
RV CVn	54220.46496	0.00129	W	Sec	WASP - This paper
RV CVn	54223.42788	0.00196	W	Sec	WASP - This paper
RV CVn	54225.45074	0.00033	W	Prim	WASP - This paper
RV CVn	54225.58179	0.00150	W	Sec	WASP - This paper
RV CVn	54226.39204	0.00036	W	Sec	WASP - This paper
RV CVn	54227.47101	0.00032	W	Sec	WASP - This paper
RV CVn	54227.60386	0.00148	W	Prim	WASP - This paper
RV CVn	54228.54932	0.00078	W	Sec	WASP - This paper
RV CVn	54230.43607	0.00039	W	Sec	WASP - This paper
RV CVn	54230.57068	0.00109	W	Prim	WASP - This paper
RV CVn	54231.51364	0.00050	W	Sec	WASP - This paper
RV CVn	54232.45848	0.00059	W	Prim	WASP - This paper
RV CVn	54232.59177	0.00088	W	Sec	WASP - This paper
RV CVn	54233.40112	0.00036	W	Sec	WASP - This paper
RV CVn	54233.53506	0.00073	W	Prim	WASP - This paper
RV CVn	54234.47736	0.00072	W	Sec	WASP - This paper
RV CVn	54235.42344	0.00036	W	Prim	WASP - This paper
RV CVn	54235.55610	0.00090	W	Sec	WASP - This paper
RV CVn	54236.50084	0.00056	W	Prim	WASP - This paper
RV CVn	54238.92591	0.00190	L	Prim	LINEAR - This paper
RV CVn	54239.05972	0.00077	L	Sec	LINEAR - This paper
RV CVn	54247.55183	0.00076	W	Prim	WASP - This paper
RV CVn	54249.44244	0.00239	W	Prim	WASP - This paper
RV CVn	54251.46014	0.00282	W	Sec	WASP - This paper
RV CVn	54252.40547	0.00019	W	Prim	WASP - This paper
RV CVn	54252.53974	0.00069	W	Sec	WASP - This paper
RV CVn	54254.42680	0.00055	W	Sec	WASP - This paper
RV CVn	54256.44966	0.00063	W	Prim	WASP - This paper
RV CVn	54260.49197	0.00099	W	Prim	WASP - This paper
RV CVn	54261.43610	0.00067	W	Sec	WASP - This paper
RV CVn	54262.51375	0.00052	W	Sec	WASP - This paper
RV CVn	54263.45781	0.00046	W	Prim	WASP - This paper
RV CVn	54264.53589	0.00190	W	Prim	WASP - This paper
RV CVn	54265.47853	0.00058	W	Sec	WASP - This paper
RV CVn	54266.42390	0.00038	W	Prim	WASP - This paper
RV CVn	54742.47247	0.00097	W	Prim	WASP - This paper
RV CVn	54742.60916	0.00067	W	Sec	WASP - This paper
RV CVn	54841.67802	0.00010	R	Prim	This paper
RV CVn	54950.7203	0.0010	V	Sec	Diethelm (2009)
RV CVn	54950.8540	0.0006	V	Prim	Diethelm (2009)
RV CVn	55492.00461	0.00032	V	Sec	CRTS - This paper
RV CVn	55492.14073	0.00038	V	Prim	CRTS - This paper
RV CVn	55629.8931	0.0003	V	Prim	Diethelm (2011)
RV CVn	56001.8955	0.0002	V	Prim	Diethelm (2012)
RV CVn	56002.56845	0.00006	R	Sec	This paper

Note: W - special filter of the WASP survey, L - special filter of the LINEAR survey

TABLE 8
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
RV CVn	56175.62512	0.00136	V	Sec	CRTS - This paper
RV CVn	56175.76114	0.00029	V	Prim	CRTS - This paper
RV CVn	56406.37806	0.00009	R	Sec	This paper
RV CVn	56443.71346	0.00029	BVR	Prim	Diethelm (2013)
RV CVn	56497.35703	0.00007	R	Prim	This paper
RV CVn	56657.61426	0.00010	R	Sec	This paper
CR Cas	16711.37			Prim	Kukarkin (1955)
CR Cas	17793.438			Prim	Kukarkin (1955)
CR Cas	28100.421			Prim	Nielsen (1937)
CR Cas	29165.410			Prim	Kukarkin (1955)
CR Cas	29462.260			Sec	Kukarkin (1955)
CR Cas	29486.46			Prim	Kukarkin (1955)
CR Cas	30321.440			Prim	Häussler (1973)
CR Cas	30940.59			Prim	Nielsen (1937)
CR Cas	31443.331			Prim	Häussler (1973)
CR Cas	33329.18			Prim	Kukarkin (1955)
CR Cas	33357.539			Prim	Kukarkin (1955)
CR Cas	33925.544			Prim	Häussler (1973)
CR Cas	34121.540			Prim	Häussler (1973)
CR Cas	35223.492			Prim	Häussler (1973)
CR Cas	35757.528			Prim	Häussler (1973)
CR Cas	35814.322			Prim	Häussler (1973)
CR Cas	36541.355			Prim	Häussler (1973)
CR Cas	36598.260			Prim	Häussler (1973)
CR Cas	36815.552			Sec	Häussler (1973)
CR Cas	37082.441			Sec	Häussler (1973)
CR Cas	37082.452			Sec	Häussler (1973)
CR Cas	37349.452			Sec	Häussler (1973)
CR Cas	37944.510			Prim	Häussler (1973)
CR Cas	38373.382			Prim	Häussler (1973)
CR Cas	38410.344			Prim	Häussler (1973)
CR Cas	39029.461			Prim	Häussler (1973)
CR Cas	39056.451			Sec	Häussler (1973)
CR Cas	39330.501			Prim	Häussler (1973)
CR Cas	39800.565			Sec	Häussler (1973)
CR Cas	40148.446			Prim	Häussler (1973)
CR Cas	40232.319			Sec	Häussler (1973)
CR Cas	40526.33			Prim	Rosino et al. (1976)
CR Cas	40563.27			Prim	Rosino et al. (1976)
CR Cas	41361.265			Prim	Häussler (1973)
CR Cas	41598.439			Sec	Häussler (1973)
CR Cas	41736.27			Prim	Rosino et al. (1976)
CR Cas	41973.328			Sec	Häussler (1973)
CR Cas	41980.394			Prim	Häussler (1973)
CR Cas	43792.490			Prim	Häussler (1973)
CR Cas	46442.308			Prim	Brelstaff (1987)
CR Cas	46902.406			Prim	Locher (1987)
CR Cas	47791.39			Prim	Brelstaff (1992)
CR Cas	48518.466	0.005		Prim	Locher (1992)
CR Cas	48819.550	0.012		Prim	Locher (1992)
CR Cas	51282.0900		V	Prim	Paschke & Brát (2006)
CR Cas	51353.10218	0.01070	C	Prim	NSVS - This paper
CR Cas	51418.42238	0.00821	C	Prim	NSVS - This paper
CR Cas	51419.82755	0.00881	C	Sec	NSVS - This paper
CR Cas	51495.10849	0.00775	C	Prim	NSVS - This paper
CR Cas	51496.53042	0.00622	C	Sec	NSVS - This paper
CR Cas	51925.271	0.010		Sec	Diethelm (2001)
CR Cas	52858.43638			Prim	Brát et al. (2007)
CR Cas	52875.47954			Prim	Brát et al. (2007)
CR Cas	52878.32594	0.03689	V	Prim	OMC - This paper
CR Cas	52879.74393	0.00596	V	Sec	OMC - This paper
CR Cas	52909.55984			Prim	Brát et al. (2007)
CR Cas	53318.55298	0.00170	V	Prim	OMC - This paper
CR Cas	53319.99489	0.00738	V	Sec	OMC - This paper
CR Cas	53733.22096	0.08520	V	Prim	OMC - This paper
CR Cas	53734.65771	0.00468	V	Sec	OMC - This paper
CR Cas	55082.3348	0.0010	C	Prim	Hübscher et al. (2010)
CR Cas	55204.46230	0.00148	V	Prim	OMC - This paper
CR Cas	55502.6830	0.0004	V	Prim	Diethelm (2011)
CR Cas	55575.11494	0.00497	V	Sec	OMC - This paper
CR Cas	55769.66837	0.00094	V	Prim	OMC - This paper
CR Cas	55836.40797	0.00049	R	Sec	Zasche et al. (2011)
CR Cas	55836.4147	0.0015	C	Sec	Hübscher & Lehmann (2012)
CR Cas	55866.23094	0.00027	R	Prim	Zasche et al. (2011)
CR Cas	56076.40594	0.00013	R	Prim	This paper
CR Cas	56502.43645	0.00013	R	Prim	This paper
CR Cas	56526.57935	0.00029	R	Sec	This paper
GV Cyg	25768.383			Prim	Ahnert et al. (1941)
GV Cyg	25879.419			Prim	Ahnert et al. (1941)
GV Cyg	26064.639			Prim	Ahnert et al. (1941)
GV Cyg	26194.450			Prim	Ahnert et al. (1941)
GV Cyg	26508.510			Prim	Ahnert et al. (1941)
GV Cyg	26743.258			Prim	Ahnert et al. (1941)
GV Cyg	26812.598			Prim	Ahnert et al. (1941)
GV Cyg	26930.527			Prim	Ahnert et al. (1941)
GV Cyg	26945.375			Prim	Ahnert et al. (1941)
GV Cyg	26946.342			Prim	Ahnert et al. (1941)

TABLE 9
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
GV Cyg	27042.438			Prim	Ahnert et al. (1941)
GV Cyg	27061.259			Prim	Ahnert et al. (1941)
GV Cyg	29494.363			Prim	Ahnert et al. (1941)
GV Cyg	29495.356			Prim	Ahnert et al. (1941)
GV Cyg	29496.347			Prim	Ahnert et al. (1941)
GV Cyg	29575.603			Prim	Ahnert et al. (1941)
GV Cyg	29576.589			Prim	Ahnert et al. (1941)
GV Cyg	29578.566			Prim	Ahnert et al. (1941)
GV Cyg	37970.4840			Prim	Busch & Häussler (1986)
GV Cyg	37973.4340			Prim	Busch & Häussler (1986)
GV Cyg	37992.2630			Prim	Busch & Häussler (1986)
GV Cyg	44117.5340			Prim	Busch & Häussler (1986)
GV Cyg	44118.5280			Prim	Busch & Häussler (1986)
GV Cyg	44131.4150			Prim	Busch & Häussler (1986)
GV Cyg	44133.3840			Prim	Busch & Häussler (1986)
GV Cyg	44134.3760			Prim	Busch & Häussler (1986)
GV Cyg	44136.3610			Prim	Busch & Häussler (1986)
GV Cyg	44143.3010			Prim	Busch & Häussler (1986)
GV Cyg	44253.2520			Prim	Busch & Häussler (1986)
GV Cyg	44256.2330			Prim	Busch & Häussler (1986)
GV Cyg	44257.2340			Prim	Busch & Häussler (1986)
GV Cyg	47095.4867			Prim	Mánek et al. (1992)
GV Cyg	47305.5049			Prim	Mánek et al. (1992)
GV Cyg	47413.4881			Prim	Mánek et al. (1992)
GV Cyg	47414.4798			Prim	Mánek et al. (1992)
GV Cyg	47414.4819			Prim	Mánek et al. (1992)
GV Cyg	47414.4826			Prim	Mánek et al. (1992)
GV Cyg	47414.4847			Prim	Mánek et al. (1992)
GV Cyg	47415.4742			Prim	Mánek et al. (1992)
GV Cyg	48156.4853			Prim	Borovička et al. (1995)
GV Cyg	50283.4538	0.0006	C	Prim	Diethelm (1996)
GV Cyg	50717.3692	0.0007	C	Prim	Diethelm (1998a)
GV Cyg	51029.4304	0.0008	C	Prim	Diethelm (1998b)
GV Cyg	51773.4174	0.0006	C	Prim	Locher (2000)
GV Cyg	52085.4726	0.0004	C	Prim	Diethelm (2001)
GV Cyg	52085.4742	0.0024	C	Prim	Brát et al. (2007)
GV Cyg	52829.4562	0.0001	R	Prim	Kotková & Wolf (2006)
GV Cyg	52876.5170	0.0005	I	Sec	Hübscher (2005)
GV Cyg	52949.3279	0.0022	R	Prim	Zejda (2004)
GV Cyg	53246.5307	0.0002	R	Prim	Zejda et al. (2006)
GV Cyg	53249.50151	0.00007	R	Prim	Kotková & Wolf (2006)
GV Cyg	54006.3710	0.0014	C	Prim	Hübscher & Walter (2007)
GV Cyg	54062.3514	0.0024	I	Sec	Hübscher & Walter (2007)
GV Cyg	54312.4833	0.0006	I	Prim	Hübscher et al. (2008)
GV Cyg	54317.43688	0.0001	I	Prim	Brát et al. (2009)
GV Cyg	54748.37494	0.00003	V	Prim	Zasche et al. (2011)
GV Cyg	55050.5301	0.0004	I	Prim	Hübscher et al. (2010)
GV Cyg	55059.4457	0.0004	I	Prim	Hübscher et al. (2010)
GV Cyg	55062.4175	0.0007	I	Prim	Hübscher et al. (2010)
GV Cyg	55064.3989	0.0011	I	Prim	Hübscher et al. (2010)
GV Cyg	55102.5397	0.0017	I	Sec	Hübscher et al. (2010)
GV Cyg	55371.5062	0.00011	RV	Prim	Web source (*)
GV Cyg	55377.45011	0.00005	R	Prim	This paper
GV Cyg	55386.36611	0.00004	R	Prim	This paper
GV Cyg	55420.5413	0.00066	RV	Sec	Web source (*)
GV Cyg	55479.4902	0.0021	I	Prim	Hübscher (2011)
GV Cyg	55482.4625	0.0015	I	Prim	Hübscher (2011)
GV Cyg	55799.47497	0.00004	R	Prim	This paper
GV Cyg	55820.27917	0.00018	R	Prim	This paper
GV Cyg	55850.49502	0.00035	R	Sec	This paper
GV Cyg	55858.4211	0.0037	I	Sec	Hübscher & Lehmann (2012)
GV Cyg	55991.66449	0.00006	R	Prim	This paper
GV Cyg	56167.5114	0.0103	I	Sec	Hübscher & Lehmann (2013)
GV Cyg	56499.37830	0.00066	R	Sec	This paper
GV Cyg	56527.61333	0.00009	R	Prim	This paper
V432 Per	35874.370			Prim	Busch et al. (1979)
V432 Per	36460.505			Prim	Busch et al. (1979)
V432 Per	36852.601			Prim	Busch et al. (1979)
V432 Per	37946.555			Prim	Busch et al. (1979)
V432 Per	37959.581			Prim	Busch et al. (1979)
V432 Per	38240.553			Prim	Busch et al. (1979)
V432 Per	38289.609			Prim	Busch et al. (1979)
V432 Per	38317.592			Prim	Busch et al. (1979)
V432 Per	38322.569			Prim	Busch et al. (1979)
V432 Per	38325.637			Prim	Busch et al. (1979)
V432 Per	38331.587			Sec	Busch et al. (1979)
V432 Per	38356.491			Sec	Busch et al. (1979)
V432 Per	38370.465			Prim	Busch et al. (1979)
V432 Per	38371.278			Prim	Busch et al. (1979)
V432 Per	38373.353			Sec	Busch et al. (1979)
V432 Per	38373.531			Prim	Busch et al. (1979)
V432 Per	38385.426			Prim	Busch et al. (1979)
V432 Per	38399.236			Prim	Busch et al. (1979)
V432 Per	38399.418			Sec	Busch et al. (1979)
V432 Per	38406.495			Prim	Busch et al. (1979)
V432 Per	38410.346			Prim	Busch et al. (1979)
V432 Per	38439.290			Sec	Busch et al. (1979)

Note: (*) - <http://physics.muni.cz/~chm/dizina.pdf>

TABLE 10
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
V432 Per	38440.404			Sec	Busch et al. (1979)
V432 Per	38670.600			Prim	Hoffmeister (1968)
V432 Per	39038.566			Prim	Busch et al. (1979)
V432 Per	39058.540			Prim	Busch et al. (1979)
V432 Per	39151.292			Prim	Busch et al. (1979)
V432 Per	39436.440			Prim	Hoffmeister (1968)
V432 Per	39527.281			Prim	Busch et al. (1979)
V432 Per	40624.295			Prim	Busch et al. (1979)
V432 Per	40863.492			Prim	Pinto & Romano (1976)
V432 Per	40863.503			Prim	Pinto & Romano (1976)
V432 Per	41008.385			Prim	Pinto & Romano (1976)
V432 Per	41008.395			Prim	Pinto & Romano (1976)
V432 Per	41272.470			Prim	Pinto & Romano (1976)
V432 Per	41335.320			Prim	Busch et al. (1979)
V432 Per	41363.306			Prim	Busch et al. (1979)
V432 Per	41417.327			Prim	Busch et al. (1979)
V432 Per	41657.316			Prim	Pinto & Romano (1976)
V432 Per	41717.304			Sec	Busch et al. (1979)
V432 Per	42841.344			Prim	Dahm (1994)
V432 Per	42988.562			Prim	Dahm (1994)
V432 Per	44166.467			Prim	Dahm (1994)
V432 Per	45268.472			Prim	Dahm (1994)
V432 Per	46360.526			Prim	Dahm (1994)
V432 Per	46705.501			Prim	Dahm (1994)
V432 Per	46763.397			Prim	Dahm (1994)
V432 Per	47174.307			Prim	Dahm (1994)
V432 Per	47205.364			Prim	Dahm (1994)
V432 Per	47207.265			Prim	Dahm (1994)
V432 Per	47862.358			Prim	Dahm (1994)
V432 Per	47924.393			Prim	Peter (1990)
V432 Per	47929.376			Prim	Peter (1990)
V432 Per	47946.407			Sec	Peter (1990)
V432 Per	47956.355			Prim	Peter (1990)
V432 Per	48128.548			Sec	Vandenbroere (1990)
V432 Per	48163.451			Sec	Vandenbroere (1990)
V432 Per	48176.474			Sec	Vandenbroere (1990)
V432 Per	48187.390			Prim	Dahm (1994)
V432 Per	48189.435			Sec	Vandenbroere (1990)
V432 Per	48481.598	0.005		Sec	Vandenbroere (1991)
V432 Per	48484.636	0.002		Sec	Vandenbroere (1991)
V432 Per	48487.525	0.004		Prim	Vandenbroere (1991)
V432 Per	48601.3739		B	Prim	Agerer (1992)
V432 Per	48601.3741		V	Prim	Agerer (1992)
V432 Per	48602.3331		B	Sec	Agerer (1992)
V432 Per	48602.3338		V	Sec	Agerer (1992)
V432 Per	48602.5246		V	Prim	Agerer (1992)
V432 Per	48602.5247		B	Prim	Agerer (1992)
V432 Per	48624.3711		B	Prim	Agerer (1992)
V432 Per	48624.3713		V	Prim	Agerer (1992)
V432 Per	48624.5662		V	Sec	Agerer (1992)
V432 Per	48624.5675		B	Sec	Agerer (1992)
V432 Per	48645.4552		V	Prim	Agerer (1992)
V432 Per	48832.5116		B	Prim	Agerer (1992)
V432 Per	48832.5118		V	Prim	Agerer (1992)
V432 Per	48893.4584		B	Prim	Agerer (1992)
V432 Per	48893.4590		V	Prim	Agerer (1992)
V432 Per	49268.3380	0.0005		Prim	Hübscher et al. (1994)
V432 Per	49268.3383	0.0002		Prim	Hübscher et al. (1994)
V432 Per	49279.462	0.003		Prim	Vandenbroere (1994)
V432 Per	49371.4483	0.0012		Prim	Hübscher et al. (1994)
V432 Per	49371.4502	0.0013		Prim	Hübscher et al. (1994)
V432 Per	49636.5100	0.0008		Sec	Agerer & Hübscher (1995)
V432 Per	49636.5108	0.0004		Sec	Agerer & Hübscher (1995)
V432 Per	50458.126			Prim	Maehara (1997)
V432 Per	50459.126			Sec	Maehara (1997)
V432 Per	50718.4086	0.0006	BV	Prim	Agerer et al. (1999)
V432 Per	50718.6009	0.0004	BV	Sec	Agerer et al. (1999)
V432 Per	50799.281	0.003		Prim	Vandenbroere (1999)
V432 Per	50812.1304		BV	Sec	Yang & Liu (2002)
V432 Per	50813.0882		BV	Prim	Yang & Liu (2002)
V432 Per	51099.411	0.005		Prim	Vandenbroere (1999)
V432 Per	51163.2403	0.0009		Sec	Vandenbroere (1999)
V432 Per	51370.8010			Prim	Paschke & Brát (2006)
V432 Per	51602.3310			Prim	Šafář (2002)
V432 Per	51797.44120			Prim	Brát et al. (2007)
V432 Per	51889.8058	0.0001	C	Prim	Nelson (2001)
V432 Per	51901.2965	0.0017	V	Prim	Agerer & Hübscher (2002)
V432 Per	51911.2699	0.0008	R	Prim	Pribulla et al. (2001)
V432 Per	51911.2714	0.0007	B	Prim	Pribulla et al. (2001)
V432 Per	51911.2728	0.0012	V	Prim	Pribulla et al. (2001)
V432 Per	51960.334	0.002		Prim	Diethelm (2001)
V432 Per	52193.3865	0.0006		Prim	Blättler (2001)
V432 Per	52320.2634	0.0002	UBV	Prim	Pribulla et al. (2002)
V432 Per	52516.9010	0.00004	C	Prim	Nelson (2003)
V432 Per	52547.3745	0.0003	UBV	Sec	Pribulla et al. (2002)
V432 Per	52547.5653	0.0003	UBV	Prim	Pribulla et al. (2002)
V432 Per	52550.8236	0.0004	C	Sec	Nelson (2003)

TABLE 11
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
V432 Per	52578.4229	0.0002	C	Sec	Bakis et al. (2003)
V432 Per	52585.3201	0.0003	BV	Sec	Pribulla et al. (2002)
V432 Per	52588.0021		V	Sec	Nakajima (2003)
V432 Per	52588.1943		V	Prim	Nakajima (2003)
V432 Per	52617.9042		V	Sec	Nakajima (2003)
V432 Per	52618.0953		V	Prim	Nakajima (2003)
V432 Per	52897.52960	0.0001	R	Prim	Kotková & Wolf (2006)
V432 Per	52902.5124	0.0001	I	Prim	Hübscher (2005)
V432 Per	52917.4605	0.0002	C	Prim	Bakis et al. (2003)
V432 Per	52924.3608	0.0001	C	Prim	Krajci (2005)
V432 Per	52927.6188	0.0001	VRI	Sec	Pribulla et al. (2005)
V432 Per	52941.4189	0.0001	VRI	Sec	Pribulla et al. (2005)
V432 Per	52941.6096	0.0001	VR	Prim	Pribulla et al. (2005)
V432 Per	52949.4700	0.0038	R	Sec	Zejda (2004)
V432 Per	52949.6590	0.0029	R	Prim	Zejda (2004)
V432 Per	52981.4757	0.0004	I	Prim	Hübscher (2005)
V432 Per	53022.1057	0.0009	C	Prim	Krajci (2005)
V432 Per	53316.4889	0.0030	I	Prim	Hübscher et al. (2005)
V432 Per	53317.2568	0.0002	C	Prim	Kim et al. (2006)
V432 Per	53345.2378	0.0001	VRI	Prim	Pribulla et al. (2005)
V432 Per	53631.1896		V	Prim	Maehara (2006)
V432 Per	53649.39671	0.0001	R	Sec	Brát et al. (2007)
V432 Per	53683.3202	0.0008	I	Prim	Hübscher et al. (2006)
V432 Per	53686.00387	0.00007	C	Prim	Kim et al. (2006)
V432 Per	53689.0702	0.0001	C	Prim	Kim et al. (2006)
V432 Per	53693.28634	0.00008	C	Prim	Kim et al. (2006)
V432 Per	53701.3355	0.0003	I	Prim	Hübscher et al. (2006)
V432 Per	53705.5526	0.0009	I	Prim	Hübscher et al. (2006)
V432 Per	53983.4548	0.0003	C	Prim	Dogru et al. (2007)
V432 Per	53992.4620	0.0001	V	Sec	Csizmadia et al. (2006)
V432 Per	54002.42856	0.0001	R	Sec	Brát et al. (2007)
V432 Per	54003.3866	0.0001	V	Prim	Parimucha et al. (2007)
V432 Per	54016.802	0.001	R	Prim	Nelson (2007)
V432 Per	54017.5696	0.0001	V	Prim	Parimucha et al. (2007)
V432 Per	54093.2740	0.0003	I	Sec	Hübscher (2007)
V432 Per	54117.2300	0.0001	R	Prim	Liakos & Niarchos (2009)
V432 Per	54131.6044	0.0005	VRI	Sec	Nelson (2008)
V432 Per	54131.7959	0.0002	VRI	Prim	Nelson (2008)
V432 Per	54133.7124	0.0002	VRI	Prim	Nelson (2008)
V432 Per	54134.7123	0.0001	VRI	Sec	Nelson (2008)
V432 Per	54135.4386	0.0015		Sec	This paper
V432 Per	54174.3426	0.0011		Prim	This paper
V432 Per	54185.6516	0.0005	R	Sec	Nelson (2008)
V432 Per	54389.3808	0.0001	V	Prim	Borkovits et al. (2008)
V432 Per	54418.7038	0.0002	VRI	Sec	Nelson (2008)
V432 Per	54434.2272	0.0001	C	Prim	Parimucha et al. (2009)
V432 Per	54480.4152	0.0005	C	Sec	Parimucha et al. (2009)
V432 Per	54489.4239	0.0003	C	Prim	Parimucha et al. (2009)
V432 Per	54514.3379	0.0004	I	Prim	Hübscher et al. (2010)
V432 Per	54799.1376		V	Prim	Itoh (2009)
V432 Per	54819.8346	0.0001	R	Prim	Nelson (2009)
V432 Per	54827.3088	0.0002	UI	Sec	Hübscher et al. (2010)
V432 Per	54831.7196	0.0006	V	Prim	Diethelm (2009)
V432 Per	54831.3352	0.0004	I	Prim	Hübscher et al. (2010)
V432 Per	54831.5255	0.0004	I	Sec	Hübscher et al. (2010)
V432 Per	54842.2597	0.0006	I	Sec	Hübscher et al. (2010)
V432 Per	54842.4516	0.0006	I	Prim	Hübscher et al. (2010)
V432 Per	54841.6843	0.0001	V	Prim	Dvorak (2010)
V432 Per	54871.5814	0.0001	V	Prim	Dvorak (2010)
V432 Per	55052.5010	0.0001	V	Prim	Parimucha et al. (2011)
V432 Per	55065.9185	0.0002	R	Prim	Nelson (2010)
V432 Per	55076.4580	0.0001	V	Sec	Parimucha et al. (2011)
V432 Per	55095.4324	0.0002	V	Prim	Parimucha et al. (2011)
V432 Per	55155.4190	0.0005	I	Sec	Hübscher et al. (2010)
V432 Per	55155.6122	0.0011	I	Prim	Hübscher et al. (2010)
V432 Per	55181.6748	0.0001	V	Prim	Diethelm (2010)
V432 Per	55212.3414	0.0001	V	Prim	Parimucha et al. (2011)
V432 Per	55477.3971	0.0002	R	Sec	Parimucha et al. (2011)
V432 Per	55484.8719	0.0001	V	Prim	Diethelm (2011)
V432 Per	55555.9721		V	Sec	Itoh (2011)
V432 Per	55800.5236	0.0002	V	Sec	Parimucha et al. (2013)
V432 Per	55846.9043	0.0003	V	Sec	Diethelm (2012)
V432 Per	55849.3930	0.0022	C	Prim	Hübscher & Lehmann (2013)
V432 Per	55849.5905	0.0054	C	Sec	Hübscher & Lehmann (2013)
V432 Per	55882.1662		V	Sec	Itoh (2012)
V432 Per	55887.5332	0.0001	UI	Sec	Hübscher & Lehmann (2013)
V432 Per	55894.2424	0.0006	I	Prim	Hübscher & Lehmann (2012)
V432 Per	55894.4322	0.0020	I	Sec	Hübscher & Lehmann (2012)
V432 Per	56182.4883	0.0003	R	Prim	Parimucha et al. (2013)
V432 Per	56222.5454	0.0005	V	Sec	Parimucha et al. (2013)
V432 Per	56249.9515		G	Prim	Itoh (2013)
V432 Per	56251.1011		V	Prim	Itoh (2013)
V432 Per	56251.2926		V	Sec	Itoh (2013)
V432 Per	56297.6737	0.0002	V	Sec	Diethelm (2013)
V432 Per	56525.54899	0.00008	R	Prim	This paper
V432 Per	56526.50790	0.00012	R	Sec	This paper
V432 Per	56550.46358	0.0001	I	Prim	Hoňková & Jůryšek (2013)

TABLE 12
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
BD +42 2782	41867.79666	0.00287	B	Prim	Sokolovsky & Antipin (2003b)
BD +42 2782	41867.99227	0.00625	B	Sec	Sokolovsky & Antipin (2003b)
BD +42 2782	42266.07510	0.00217	B	Prim	Sokolovsky & Antipin (2003b)
BD +42 2782	42266.26996	0.00272	B	Sec	Sokolovsky & Antipin (2003b)
BD +42 2782	42846.11464	0.00676	B	Prim	Sokolovsky & Antipin (2003b)
BD +42 2782	42846.29986	0.00577	B	Sec	Sokolovsky & Antipin (2003b)
BD +42 2782	44019.49849	0.00308	B	Prim	Sokolovsky & Antipin (2003b)
BD +42 2782	44019.67193	0.03137	B	Sec	Sokolovsky & Antipin (2003b)
BD +42 2782	44423.2737		B	Prim	Sokolovsky & Antipin (2003b)
BD +42 2782	45537.68666	0.00277	B	Sec	Sokolovsky & Antipin (2003b)
BD +42 2782	45537.87380	0.00317	B	Prim	Sokolovsky & Antipin (2003b)
BD +42 2782	48459.28200	0.0045	$B_T V_T$	Sec	TYCHO - This paper
BD +42 2782	51312.59984	0.00206	C	Prim	NSVS - This paper
BD +42 2782	51312.78408	0.00082	C	Sec	NSVS - This paper
BD +42 2782	51376.07968	0.00096	C	Sec	NSVS - This paper
BD +42 2782	51376.26830	0.00123	C	Prim	NSVS - This paper
BD +42 2782	51429.38675	0.00466	C	Sec	NSVS - This paper
BD +42 2782	51429.57057	0.00092	C	Prim	NSVS - This paper
BD +42 2782	51475.28723	0.00058	C	Sec	NSVS - This paper
BD +42 2782	51475.47079	0.00566	C	Prim	NSVS - This paper
BD +42 2782	53128.56228	0.00032	W	Prim	WASP - This paper
BD +42 2782	53129.67415	0.00035	W	Prim	WASP - This paper
BD +42 2782	53130.59945	0.00024	W	Sec	WASP - This paper
BD +42 2782	53132.63466	0.00037	W	Prim	WASP - This paper
BD +42 2782	53137.63098	0.00018	W	Sec	WASP - This paper
BD +42 2782	53138.55720	0.00023	W	Prim	WASP - This paper
BD +42 2782	53139.66729	0.00009	W	Prim	WASP - This paper
BD +42 2782	53140.59279	0.00021	W	Sec	WASP - This paper
BD +42 2782	53141.51746	0.00032	W	Prim	WASP - This paper
BD +42 2782	53141.70245	0.00066	W	Sec	WASP - This paper
BD +42 2782	53153.54832	0.00032	W	Sec	WASP - This paper
BD +42 2782	53154.47270	0.00025	W	Prim	WASP - This paper
BD +42 2782	53154.65841	0.00025	W	Sec	WASP - This paper
BD +42 2782	53155.58286	0.00027	W	Prim	WASP - This paper
BD +42 2782	53156.50958	0.00017	W	Sec	WASP - This paper
BD +42 2782	53156.69380	0.00047	W	Prim	WASP - This paper
BD +42 2782	53157.43370	0.00021	W	Prim	WASP - This paper
BD +42 2782	53157.61940	0.00034	W	Sec	WASP - This paper
BD +42 2782	53158.54451	0.00028	W	Prim	WASP - This paper
BD +42 2782	53159.46980	0.00021	W	Sec	WASP - This paper
BD +42 2782	53159.65502	0.00024	W	Prim	WASP - This paper
BD +42 2782	53160.58022	0.00024	W	Sec	WASP - This paper
BD +42 2782	53161.50652	0.00019	W	Prim	WASP - This paper
BD +42 2782	53161.69000	0.00138	W	Sec	WASP - This paper
BD +42 2782	53162.43056	0.00038	W	Sec	WASP - This paper
BD +42 2782	53162.61626	0.00022	W	Prim	WASP - This paper
BD +42 2782	53163.54244	0.00026	W	Sec	WASP - This paper
BD +42 2782	53164.65205	0.00029	W	Sec	WASP - This paper
BD +42 2782	53164.6523	0.0002	RI	Sec	Lu et al. (2007)
BD +42 2782	53165.57716	0.00027	W	Prim	WASP - This paper
BD +42 2782	53166.50324	0.00018	W	Sec	WASP - This paper
BD +42 2782	53166.68748	0.00027	W	Prim	WASP - This paper
BD +42 2782	53167.42844	0.00038	W	Prim	WASP - This paper
BD +42 2782	53167.61350	0.00018	W	Sec	WASP - This paper
BD +42 2782	53168.53770	0.00029	W	Prim	WASP - This paper
BD +42 2782	53169.46464	0.00037	W	Sec	WASP - This paper
BD +42 2782	53169.64815	0.00019	W	Prim	WASP - This paper
BD +42 2782	53170.57520	0.00027	W	Sec	WASP - This paper
BD +42 2782	53170.7596	0.0001	RI	Prim	Lu et al. (2007)
BD +42 2782	53171.49962	0.00019	W	Prim	WASP - This paper
BD +42 2782	53172.60955	0.00029	W	Prim	WASP - This paper
BD +42 2782	53173.53645	0.00038	W	Sec	WASP - This paper
BD +42 2782	53174.46111	0.00018	W	Prim	WASP - This paper
BD +42 2782	53174.64640	0.00034	W	Sec	WASP - This paper
BD +42 2782	53175.56965	0.00065	W	Prim	WASP - This paper
BD +42 2782	53178.53250	0.00041	W	Prim	WASP - This paper
BD +42 2782	53180.56866	0.00040	W	Sec	WASP - This paper
BD +42 2782	53181.49434	0.00029	W	Prim	WASP - This paper
BD +42 2782	53183.53070	0.00061	W	Sec	WASP - This paper
BD +42 2782	53184.45483	0.00023	W	Prim	WASP - This paper
BD +42 2782	53185.56450	0.00032	W	Prim	WASP - This paper
BD +42 2782	53188.52631	0.00034	W	Prim	WASP - This paper
BD +42 2782	53189.45238	0.00027	W	Sec	WASP - This paper
BD +42 2782	53190.56243	0.00046	W	Sec	WASP - This paper
BD +42 2782	53191.48853	0.00061	W	Prim	WASP - This paper
BD +42 2782	53192.41371	0.00035	W	Sec	WASP - This paper
BD +42 2782	53192.59784	0.00085	W	Prim	WASP - This paper
BD +42 2782	53193.52351	0.00068	W	Sec	WASP - This paper
BD +42 2782	53194.44901	0.00025	W	Prim	WASP - This paper
BD +42 2782	53195.55916	0.00032	W	Prim	WASP - This paper
BD +42 2782	53196.48520	0.00069	W	Sec	WASP - This paper
BD +42 2782	53197.41023	0.00047	W	Prim	WASP - This paper
BD +42 2782	53198.52082	0.00019	W	Prim	WASP - This paper
BD +42 2782	53199.44620	0.00023	W	Sec	WASP - This paper
BD +42 2782	53200.55644	0.00064	W	Sec	WASP - This paper
BD +42 2782	53201.48194	0.00028	W	Prim	WASP - This paper
BD +42 2782	53203.51772	0.00045	W	Sec	WASP - This paper

Note: W - special filter of the WASP survey

TABLE 13
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
20074 +42 2782	53205.55329	0.00062	W	Prim	WASP - This paper
20074 +42 2782	53206.48032	0.00348	W	Sec	WASP - This paper
20074 +42 2782	53207.40477	0.00025	W	Prim	WASP - This paper
20074 +42 2782	53208.51424	0.00022	W	Prim	WASP - This paper
20074 +42 2782	53209.44115	0.00069	W	Sec	WASP - This paper
20074 +42 2782	53212.40258	0.00092	W	Sec	WASP - This paper
20074 +42 2782	53217.39913	0.00085	W	Prim	WASP - This paper
20074 +42 2782	53218.50848	0.00069	W	Prim	WASP - This paper
20074 +42 2782	53219.43476	0.00046	W	Sec	WASP - This paper
20074 +42 2782	53220.54431	0.00049	W	Sec	WASP - This paper
20074 +42 2782	53223.50555	0.00018	W	Sec	WASP - This paper
BD +42 2782	53224.43112	0.00018	W	Prim	WASP - This paper
BD +42 2782	53226.46740	0.00025	W	Sec	WASP - This paper
BD +42 2782	53227.39278	0.00065	W	Prim	WASP - This paper
BD +42 2782	53228.50312	0.00026	W	Prim	WASP - This paper
BD +42 2782	53229.42877	0.00036	W	Sec	WASP - This paper
BD +42 2782	53231.46435	0.00015	W	Prim	WASP - This paper
BD +42 2782	53232.39024	0.00034	W	Sec	WASP - This paper
BD +42 2782	53236.46070	0.00059	W	Sec	WASP - This paper
BD +42 2782	53237.38668	0.00029	W	Prim	WASP - This paper
BD +42 2782	53239.42343	0.00045	W	Sec	WASP - This paper
BD +42 2782	53241.45735	0.00083	W	Prim	WASP - This paper
BD +42 2782	53242.38445	0.00042	W	Sec	WASP - This paper
BD +42 2782	53246.45520	0.00038	W	Sec	WASP - This paper
BD +42 2782	53247.38210	0.00019	W	Prim	WASP - This paper
BD +42 2782	53249.41724	0.00050	W	Sec	WASP - This paper
BD +42 2782	53252.37842	0.00038	W	Sec	WASP - This paper
BD +42 2782	53259.41142	0.00069	W	Sec	WASP - This paper
BD +42 2782	53262.37464	0.00109	W	Sec	WASP - This paper
BD +42 2782	53277.36218	0.00025	W	Prim	WASP - This paper
BD +42 2782	53282.5439	0.0005	RI	Prim	Lu et al. (2007)
BD +42 2782	53831.66078	0.00163	W	Sec	WASP - This paper
BD +42 2782	53833.69638	0.00037	W	Prim	WASP - This paper
BD +42 2782	53851.64678	0.00032	W	Sec	WASP - This paper
BD +42 2782	53852.57104	0.00027	W	Prim	WASP - This paper
BD +42 2782	53854.60804	0.00048	W	Sec	WASP - This paper
BD +42 2782	53856.64257	0.00026	W	Prim	WASP - This paper
BD +42 2782	53884.59309	0.00025	W	Sec	WASP - This paper
BD +42 2782	53885.51945	0.00059	W	Prim	WASP - This paper
BD +42 2782	53887.55706	0.00059	W	Sec	WASP - This paper
BD +42 2782	53902.54460	0.00012	W	Prim	WASP - This paper
BD +42 2782	53903.47082	0.00028	W	Sec	WASP - This paper
BD +42 2782	53903.65528	0.00020	W	Prim	WASP - This paper
BD +42 2782	53906.61562	0.00032	W	Prim	WASP - This paper
BD +42 2782	53920.49772	0.00036	W	Sec	WASP - This paper
BD +42 2782	53921.42263	0.00016	W	Prim	WASP - This paper
BD +42 2782	53922.53291	0.00033	W	Prim	WASP - This paper
BD +42 2782	53923.45877	0.00015	W	Sec	WASP - This paper
BD +42 2782	53938.44956	0.00023	W	Prim	WASP - This paper
BD +42 2782	53942.52155	0.00014	W	Prim	WASP - This paper
BD +42 2782	53943.44553	0.00011	W	Sec	WASP - This paper
BD +42 2782	53945.48266	0.00017	W	Prim	WASP - This paper
BD +42 2782	53947.51823	0.00039	W	Sec	WASP - This paper
BD +42 2782	53948.44298	0.00023	W	Prim	WASP - This paper
BD +42 2782	53950.48016	0.00160	W	Sec	WASP - This paper
BD +42 2782	54190.70567	0.00013	W	Sec	WASP - This paper
BD +42 2782	54191.63197	0.00021	W	Prim	WASP - This paper
BD +42 2782	54204.58635	0.00063	W	Prim	WASP - This paper
BD +42 2782	54206.62144	0.00023	W	Sec	WASP - This paper
BD +42 2782	54208.65838	0.00013	W	Prim	WASP - This paper
BD +42 2782	54210.69360	0.00012	W	Sec	WASP - This paper
BD +42 2782	54213.65577	0.00050	W	Sec	WASP - This paper
BD +42 2782	54214.58027	0.00030	W	Prim	WASP - This paper
BD +42 2782	54215.5055	0.0000	BVR	Sec	Gurol et al. (2007)
BD +42 2782	54216.4314	0.0001	BR	Prim	Gurol et al. (2007)
BD +42 2782	54216.61561	0.00012	W	Sec	WASP - This paper
BD +42 2782	54217.54128	0.00032	W	Prim	WASP - This paper
BD +42 2782	54218.65236	0.00017	W	Prim	WASP - This paper
BD +42 2782	54219.57700	0.00010	W	Sec	WASP - This paper
BD +42 2782	54222.53872	0.00017	W	Sec	WASP - This paper
BD +42 2782	54223.64842	0.00012	W	Sec	WASP - This paper
BD +42 2782	54225.68478	0.00082	W	Prim	WASP - This paper
BD +42 2782	54226.60977	0.00063	W	Sec	WASP - This paper
BD +42 2782	54227.53571	0.00023	W	Prim	WASP - This paper
BD +42 2782	54230.68138	0.00165	W	Sec	WASP - This paper
BD +42 2782	54231.60718	0.00011	W	Prim	WASP - This paper
BD +42 2782	54232.53280	0.00021	W	Sec	WASP - This paper
BD +42 2782	54233.64334	0.00015	W	Sec	WASP - This paper
BD +42 2782	54235.49401	0.00012	W	Sec	WASP - This paper
BD +42 2782	54235.67943	0.00010	W	Prim	WASP - This paper
BD +42 2782	54236.60458	0.00120	W	Sec	WASP - This paper
BD +42 2782	54247.52452	0.00016	W	Prim	WASP - This paper
BD +42 2782	54249.55930	0.00018	W	Sec	WASP - This paper
BD +42 2782	54250.48529	0.00015	W	Prim	WASP - This paper
BD +42 2782	54250.66947	0.00017	W	Sec	WASP - This paper
BD +42 2782	54251.59531	0.00018	W	Prim	WASP - This paper
BD +42 2782	54252.52070	0.00015	W	Sec	WASP - This paper

TABLE 14
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
BD +42 2782	54254.55660	0.00032	W	Prim	WASP - This paper
BD +42 2782	54256.59172	0.00009	W	Sec	WASP - This paper
BD +42 2782	54260.47961	0.00017	W	Prim	WASP - This paper
BD +42 2782	54261.58945	0.00015	W	Prim	WASP - This paper
BD +42 2782	54262.51469	0.00025	W	Sec	WASP - This paper
BD +42 2782	54263.44025	0.00013	W	Prim	WASP - This paper
BD +42 2782	54263.62409	0.00023	W	Sec	WASP - This paper
BD +42 2782	54264.55086	0.00011	W	Prim	WASP - This paper
BD +42 2782	54265.47480	0.00012	W	Sec	WASP - This paper
BD +42 2782	54265.66090	0.00019	W	Prim	WASP - This paper
BD +42 2782	54266.58510	0.00018	W	Sec	WASP - This paper
BD +42 2782	54267.51302	0.00021	W	Prim	WASP - This paper
BD +42 2782	54268.62233	0.00020	W	Prim	WASP - This paper
BD +42 2782	54269.54711	0.00025	W	Sec	WASP - This paper
BD +42 2782	54270.47309	0.00019	W	Prim	WASP - This paper
BD +42 2782	54271.58416	0.00028	W	Prim	WASP - This paper
BD +42 2782	54272.50774	0.00012	W	Sec	WASP - This paper
BD +42 2782	54273.43435	0.00009	W	Prim	WASP - This paper
BD +42 2782	54273.61802	0.00064	W	Sec	WASP - This paper
BD +42 2782	54274.54554	0.00029	W	Prim	WASP - This paper
BD +42 2782	54275.46864	0.00023	W	Sec	WASP - This paper
BD +42 2782	54277.50602	0.00013	W	Prim	WASP - This paper
BD +42 2782	54278.43054	0.00012	W	Sec	WASP - This paper
BD +42 2782	54278.61613	0.00018	W	Prim	WASP - This paper
BD +42 2782	54279.54120	0.00034	W	Sec	WASP - This paper
BD +42 2782	54280.46831	0.00129	W	Prim	WASP - This paper
BD +42 2782	54281.57756	0.00016	W	Prim	WASP - This paper
BD +42 2782	54282.50272	0.00047	W	Sec	WASP - This paper
BD +42 2782	54283.42913	0.00018	W	Prim	WASP - This paper
BD +42 2782	54283.61226	0.00025	W	Sec	WASP - This paper
BD +42 2782	54284.53884	0.00023	W	Prim	WASP - This paper
BD +42 2782	54285.46225	0.00075	W	Sec	WASP - This paper
BD +42 2782	54286.57374	0.00026	W	Sec	WASP - This paper
BD +42 2782	54287.49932	0.00027	W	Prim	WASP - This paper
BD +42 2782	54288.42505	0.00016	W	Sec	WASP - This paper
BD +42 2782	54289.53519	0.00023	W	Sec	WASP - This paper
BD +42 2782	54290.46105	0.00023	W	Prim	WASP - This paper
BD +42 2782	54291.57177	0.00060	W	Prim	WASP - This paper
BD +42 2782	54292.49764	0.00021	W	Sec	WASP - This paper
BD +42 2782	54293.42185	0.00034	W	Prim	WASP - This paper
BD +42 2782	54294.53252	0.00025	W	Prim	WASP - This paper
BD +42 2782	54295.45851	0.00028	W	Sec	WASP - This paper
BD +42 2782	54296.56943	0.00093	W	Sec	WASP - This paper
BD +42 2782	54297.49328	0.00049	W	Prim	WASP - This paper
BD +42 2782	54298.41994	0.00030	W	Sec	WASP - This paper
BD +42 2782	54303.41614	0.00025	W	Prim	WASP - This paper
BD +42 2782	54304.52616	0.00045	W	Prim	WASP - This paper
BD +42 2782	54305.45144	0.00028	W	Sec	WASP - This paper
BD +42 2782	54307.48786	0.00078	W	Prim	WASP - This paper
BD +42 2782	54308.41221	0.00078	W	Sec	WASP - This paper
BD +42 2782	54312.48501	0.00040	W	Sec	WASP - This paper
BD +42 2782	54356.3481	0.0002	BVR	Prim	Gokay et al. (2010)
BD +42 2782	54555.67491	0.00079	W	Sec	WASP - This paper
BD +42 2782	54558.63372	0.00033	W	Sec	WASP - This paper
BD +42 2782	54570.66458	0.00026	W	Prim	WASP - This paper
BD +42 2782	54571.59077	0.00018	W	Sec	WASP - This paper
BD +42 2782	54578.62248	0.00038	W	Sec	WASP - This paper
BD +42 2782	54579.54838	0.00038	W	Prim	WASP - This paper
BD +42 2782	54580.65941	0.00035	W	Prim	WASP - This paper
BD +42 2782	54581.58552	0.00037	W	Sec	WASP - This paper
BD +42 2782	54585.65600	0.00038	W	Sec	WASP - This paper
BD +42 2782	54586.58152	0.00025	W	Prim	WASP - This paper
BD +42 2782	54591.57903	0.00039	W	Sec	WASP - This paper
BD +42 2782	54593.61380	0.00021	W	Prim	WASP - This paper
BD +42 2782	54597.50094	0.00033	W	Sec	WASP - This paper
BD +42 2782	54597.68468	0.00055	W	Prim	WASP - This paper
BD +42 2782	54598.61126	0.00020	W	Sec	WASP - This paper
BD +42 2782	54600.64661	0.00044	W	Prim	WASP - This paper
BD +42 2782	54605.64467	0.00024	W	Sec	WASP - This paper
BD +42 2782	54606.56824	0.00021	W	Prim	WASP - This paper
BD +42 2782	54607.49518	0.00028	W	Sec	WASP - This paper
BD +42 2782	54607.79799	0.00105	W	Prim	WASP - This paper
BD +42 2782	54608.60486	0.00028	W	Sec	WASP - This paper
BD +42 2782	54609.53030	0.00012	W	Prim	WASP - This paper
BD +42 2782	54613.60167	0.00073	W	Prim	WASP - This paper
BD +42 2782	54614.52721	0.00034	W	Sec	WASP - This paper
BD +42 2782	54618.59853	0.00042	W	Sec	WASP - This paper
BD +42 2782	54619.52465	0.00012	W	Prim	WASP - This paper
BD +42 2782	54620.44972	0.00021	W	Sec	WASP - This paper
BD +42 2782	54620.63503	0.00013	W	Prim	WASP - This paper
BD +42 2782	54621.56016	0.00014	W	Sec	WASP - This paper
BD +42 2782	54622.48575	0.00014	W	Prim	WASP - This paper
BD +42 2782	54622.67008	0.00024	W	Sec	WASP - This paper
BD +42 2782	54623.59630	0.00012	W	Prim	WASP - This paper
BD +42 2782	54624.52162	0.00010	W	Sec	WASP - This paper
BD +42 2782	54625.44721	0.00014	W	Prim	WASP - This paper
BD +42 2782	54625.63176	0.00011	W	Sec	WASP - This paper

Note: W - special filter of the WASP survey

TABLE 15
THE MINIMA TIMES USED FOR THE ANALYSIS.

System	HJD-2400000	Error	Filter	Type	Reference
BD +42 2782	54626.55765	0.00010	W	Prim	WASP - This paper
BD +42 2782	54627.48290	0.00013	W	Sec	WASP - This paper
BD +42 2782	54628.40827	0.00016	W	Prim	WASP - This paper
BD +42 2782	54628.59306	0.00019	W	Sec	WASP - This paper
BD +42 2782	54629.51885	0.00023	W	Prim	WASP - This paper
BD +42 2782	54630.44382	0.00013	W	Sec	WASP - This paper
BD +42 2782	54630.62916	0.00012	W	Prim	WASP - This paper
BD +42 2782	54632.47956	0.00010	W	Prim	WASP - This paper
BD +42 2782	54632.66461	0.00015	W	Sec	WASP - This paper
BD +42 2782	54635.44091	0.00019	W	Prim	WASP - This paper
BD +42 2782	54635.62579	0.00013	W	Sec	WASP - This paper
BD +42 2782	54636.55191	0.00013	W	Prim	WASP - This paper
BD +42 2782	54637.47535	0.00024	W	Sec	WASP - This paper
BD +42 2782	54638.40274	0.00026	W	Prim	WASP - This paper
BD +42 2782	54639.51243	0.00010	W	Prim	WASP - This paper
BD +42 2782	54640.43754	0.00014	W	Sec	WASP - This paper
BD +42 2782	54640.62275	0.00044	W	Prim	WASP - This paper
BD +42 2782	54641.54844	0.00010	W	Sec	WASP - This paper
BD +42 2782	54642.47345	0.00015	W	Prim	WASP - This paper
BD +42 2782	54643.58405	0.00009	W	Prim	WASP - This paper
BD +42 2782	54644.51028	0.00038	W	Sec	WASP - This paper
BD +42 2782	54645.43527	0.00028	W	Prim	WASP - This paper
BD +42 2782	54646.54565	0.00020	W	Prim	WASP - This paper
BD +42 2782	54647.47166	0.00030	W	Sec	WASP - This paper
BD +42 2782	54648.58109	0.00026	W	Sec	WASP - This paper
BD +42 2782	54649.50640	0.00012	W	Prim	WASP - This paper
BD +42 2782	54650.43209	0.00014	W	Sec	WASP - This paper
BD +42 2782	54651.54255	0.00022	W	Sec	WASP - This paper
BD +42 2782	54652.46782	0.00019	W	Prim	WASP - This paper
BD +42 2782	54655.42933	0.00014	W	Prim	WASP - This paper
BD +42 2782	54656.53917	0.00013	W	Prim	WASP - This paper
BD +42 2782	54657.46574	0.00026	W	Sec	WASP - This paper
BD +42 2782	54659.50136	0.00017	W	Prim	WASP - This paper
BD +42 2782	54660.42613	0.00009	W	Sec	WASP - This paper
BD +42 2782	54661.53681	0.00022	W	Sec	WASP - This paper
BD +42 2782	54662.46251	0.00023	W	Prim	WASP - This paper
BD +42 2782	54663.57246	0.00036	W	Prim	WASP - This paper
BD +42 2782	54664.49910	0.00039	W	Sec	WASP - This paper
BD +42 2782	54665.42270	0.00015	W	Prim	WASP - This paper
BD +42 2782	54666.53344	0.00017	W	Prim	WASP - This paper
BD +42 2782	54669.49569	0.00080	W	Prim	WASP - This paper
BD +42 2782	54670.42141	0.00026	W	Sec	WASP - This paper
BD +42 2782	54671.53095	0.00015	W	Sec	WASP - This paper
BD +42 2782	54672.45589	0.00023	W	Prim	WASP - This paper
BD +42 2782	54674.49256	0.00026	W	Sec	WASP - This paper
BD +42 2782	54675.41761	0.00016	W	Prim	WASP - This paper
BD +42 2782	54676.52730	0.00029	W	Prim	WASP - This paper
BD +42 2782	54677.45371	0.00021	W	Sec	WASP - This paper
BD +42 2782	54680.41559	0.00039	W	Sec	WASP - This paper
BD +42 2782	54681.52496	0.00055	W	Sec	WASP - This paper
BD +42 2782	56048.49628	0.00022	C	Sec	This paper
BD +42 2782	56060.52799	0.00073	R	Prim	This paper
BD +42 2782	56390.51582	0.00021	C	Sec	This paper
BD +42 2782	56425.49596	0.00018	C	Prim	This paper
BD +42 2782	56441.41162	0.00013	R	Prim	This paper
BD +42 2782	56446.40925	0.00041	C	Sec	This paper
BD +42 2782	56450.48137	0.00009	R	Sec	This paper
BD +42 2782	56451.40635	0.00008	R	Prim	This paper
BD +42 2782	56510.44614	0.00019	R	Sec	This paper
BD +42 2782	56515.44333	0.00029	C	Prim	This paper

Note: W - special filter of the WASP survey

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